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MISSOURI BOTANICAL GARDEN BULLETIN

VOLUME III
WITH 11 PLATES
1915

ST. LOUIS, MISSOURI
PUBLISHED MONTHLY BY THE BOARD OF TRUSTEES

SUBSCRIPTION PRICE:
ONE DOLLAR PER YEAR SINGLE NUMBERS TEN CENTS

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Missouri Botanical Garden Bulletin

Vol. III JANUARY, 1915 No. 1

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BOARD OF TRUSTEES
OF THE MISSOURI BOTANICAL GARDEN

THE ORIGINAL MEMBERS WERE DESIGNATED IN MR. SHAW'S WILL, AND THE BOARD SO CONSTITUTED, EXCLUSIVE OF THE *EX-OFFICIO* MEMBERS, IS SELF-PERPETUATING.

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HERMAN MAUCH,
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Bishop of the Diocese of Missouri.

A. D. CUNNINGHAM, Secretary.

Missouri Botanical Garden Bulletin

Vol. III St. Louis, Mo., January, 1915 No. 1

REPORT OF THE OFFICERS OF THE BOARD

SUBMITTED TO THE TRUSTEES, JANUARY 13, 1915

To the Board of Trustees of the Missouri Botanical Garden:

We submit for your consideration the financial results for the year ending December 31, 1914.

The earnings from rentals have not equaled those of the year 1913 by $5,152.28 on account of vacancies and the disposal of several pieces of income property, but our income from interest on investments on deferred payments—secured by deeds of trust—on property sold exceeds the year 1913 by $6,678.88, so that our income exceeds that of the previous year by $1,526.60, but no further increase can be expected from the present holdings for the coming year.

During the year we disposed of four pieces of residence property—

1500-08 Lafayette Avenue,
1129-31 St. Ange Avenue,
3134 Morgan Street, and
2601-03 Chestnut Street—

which we gave in part exchange for a piece of business property, at the northeast corner of Fifteenth and Locust Streets, occupied by an old residence but upon which we hope to erect a building for permanent investment.

We also disposed of a piece of property—a four-story warehouse on Second Street—which was getting old and is in a section of the city where the values are doubtful, for $15,000.00.

Our loss by vacancies during the year was $1,252.00.

In addition to the tract known as Lafayette Avenue Addition—containing about 11,533 front feet, lying between Grand Avenue and Lawrence Street, of which 11,047 feet have been sold for $480,825.28—we have during the past

summer improved a tract adjoining it on the west containing about 11,860 front feet, of which we have already sold 2,633 front feet for $90,117.11.

During the year our sales of vacant ground were as follows:

Lafayette Avenue Addition No. 1	2,382 feet	$85,433	97
Lafayette Avenue Addition No. 2	2,633 feet	90,117	11
Flora Boulevard Addition	170 feet	11,090	00
		$186,641	08

We have just let contracts for grading and to prepare for subdivision a tract to be known as Lafayette Avenue Addition No. 3—lying just west of Tower Grove Avenue and north of the Garden and containing twenty acres, and another tract lying at the southeast corner of Arsenal Street and Kingshighway and just south of Tower Grove Park, containing twelve acres. Both of these tracts will be fully improved with streets and sewers as soon as it seems desirable.

No extensive permanent improvements have been made at the Garden except the following:

A reserve boiler for heating plant	$3,767 90
Pergola enclosing the area between the wings of the new plant house	3,500 00

Many other general improvements have been made at the Garden, but for particulars of these you are referred to the Director's Annual Report.

Additions to the Library and Herbarium collections by purchase and gift during the year are valued at the following sums:

Library	$3,734 29
Herbarium	6,464 05

The annual bequests provided for in Mr. Shaw's will have been carried out with the exception of prizes for the annual flower show, none being held.

The Twenty-Fifth Anniversary of the organization of the Board of Trustees of the Missouri Botanical Garden was celebrated October 14 and 15 at the Garden, scientists gathering for the occasion from Europe and from nearly all of the educational and scientific institutions of the United States and Canada. The celebration concluded with the Trustee's Annual Banquet. For full particulars you are referred to the Director's Annual Report and the October, 1914, number of the BULLETIN.

For an itemized account of the receipts and disbursements your attention is called to the following statement:

RECEIPTS

Rentals	$152,528 65	
Interest and dividends	16,605 76	
Publication sales and subscriptions	107 70	
Total income receipts		$169,242 11
Sales of real estate under decree	$102,869 81	
Sales of real estate account of endowment	5,000 00	
Notes receivable account of sales	78,001 75	
Shaw School of Botany, rentals	3,900 00	
Missouri Botanical Garden, wrecking building	220 00	
Surety Company, account of builder's bond	8,413 80	198,405 36
Total receipts		$367,647 47
Cash balance December 31st, 1913		15,730 80
		$383,378 27

DISBURSEMENTS

Garden Account —		
Labor pay-roll	$32,746 67	
Students' pay-roll	992 69	
Open Sunday pay-roll	596 00	
Office assistance	3,562 80	$37,898 16
Fuel	3,750 13	
Water	843 20	
Repairs and supplies	4,894 29	
Stable and implements	770 86	
Plants and seeds	3,753 18	
Total for care of Garden		$51,909 82
Herbarium Account —		
Salaries	$3,970 97	
Current expenses and additions	2,484 63	6,455 60
Library Account —		
Salaries	$2,414 37	
Current expenses and additions	2,348 54	4,762 91
Garden Office Account —		
Salaries	$7,856 31	
Current expenses	1,419 52	9,275 83
Research and Instruction Account —		
Salaries	$9,944 95	
Current expenses and supplies	1,770 76	11,715 71
Total maintenance		$84,119 87
Garden Improvements —		
New boiler (additional)	$ 3,767 90	
Pergola	3,500 00	
Garden improvements	10,728 87	17,996 77
Total amount expended on Garden		$102,116 64

Property Account —		
State, school and city taxes	$35,601 50	
Sprinkling taxes	1,381 49	
Streets, sidewalks and sewers	43,247 63	
Insurance	5,760 72	
Repairs	6,414 42	
Improvements	3,500 00	95,905 76
Publications Account —		
Monthly Bulletin	$1,799 28	
Annals	1,508 06	3,307 34
Bequests —		
Annual Flower Sermon	$200 00	
Annual Gardeners' Banquet	367 38	
Annual Trustees' Banquet, 25th Anniversary	5,385 78	5,953 16
Sundries —		
Office expenses	$ 6,501 67	
Legal expenses	6,065 32	
Commissions	10,760 28	
Washington University, account Shaw School of Botany	299 89	
Shaw School of Botany, rentals	3,900 00	27,527 16
Investments —		
Certificates of deposit	$73,832 11	
Real estate, 1431 Locust Street	45,000 00	
Real estate, 1-3-5 S. Main Street	6,111 00	124,943 11
Total disbursements		$359,753 17
Cash balance December 31st, 1914		23,625 10
		$383,378 27

Respectfully submitted,

EDWARDS WHITAKER, President.

Attest:

A. D. CUNNINGHAM, Secretary.

TWENTY-SIXTH ANNUAL REPORT OF THE DIRECTOR

SUBMITTED TO THE BOARD OF TRUSTEES OF THE MISSOURI BOTANICAL GARDEN, JANUARY 13, 1915

Gentlemen:

I have the honor to submit herewith the Twenty-Sixth Annual Report of the Director.

In contrast to the year 1913, which was notable for the extensive building operations, the chief additions to the Garden during 1914 have been in the nature of outdoor improvements. These include a start towards the large formal garden back of the new conservatories, the laying-out and partial planting of an English garden in the vicinity of the Linnean house, the establishment of a nursery, the planting of the knolls in the main garden, together with the general overhauling of most of the shrubbery. A new propagating house back of the wall has been constructed, an additional boiler installed at the heating plant, and the office of the General Manager moved to the main gate. For the benefit of the specialist, as well as for the general public, there has been brought together on the first floor of the old museum building a pathological exhibit. Here is shown a large collection of specimens illustrating various types of diseases of living trees, classified into diseases of hardwoods and diseases of coniferous woods. The collection is one which has been made by the Pathologist, Dr. von Schrenk, during the past twenty years, and is unusually rich in typical specimens. Besides examples of insect injuries to trees and timbers, showing the effects principally of termites, Teredo, Limnoria, Martesia, etc., there are numerous specimens of diseases of structural timbers, illustrating the more common types found on wood. Various kinds of treated timbers, showing both freshly treated material and timbers showing service tests, are likewise displayed. There have been innumerable minor changes, which of themselves are hardly worth especial mention but in the aggregate amount to a great deal in increasing the attractiveness and the efficiency of the Garden. The new residence was completed and

occupied in the early part of the year, although the greater part of it was built and paid for in 1913.

Next to the anniversary celebration, probably the most important single feature of the year's activity has been the reorganization of the school of gardening, which, because of the teaching staff and the unusual facilities offered, has very large possibilities. In this connection, the reunion of the former garden pupils, together with the organization of an alumni association, is a matter of especial interest.

The publication of a new quarterly journal, containing only scientific papers contributed by members of the staff or those actually working at the Garden, should likewise be mentioned as an important step taken this year. It may safely be said that all the various departments have been improved or augmented and that the influence and usefulness of the Garden has continued to increase.

GARDEN

The construction of a formal garden, bounded on the north, south, and east by the new conservatories, and on the west by a pergola, has been the largest single addition to the features of the main garden. The land back of the conservatory sloped so rapidly to the west that in order to level this area it was necessary to construct a reinforced concrete retaining wall, which in some places is fourteen feet in height. The fill required thousands of yards of earth; in fact, the actual making of the Garden was a small undertaking compared with the preliminary work. On top of the retaining wall there has been built an Italian pergola about 250 feet in length, the architectural features of which conform to those of the entrances to the greenhouses. This pergola, when covered with perennial vines, will constitute one of the most pleasant parts of the Garden in which to rest, the outlook over the formal garden being particularly attractive. The latter, with the aid of hedges, orange and boxwood trees, appropriate furniture and fountains, will be the most pretentious thing of its kind that has ever been attempted at the Missouri Botanical Garden. Here will be afforded an unusual place for the exhibition of tulips in the spring, and throughout the summer a succession of foliage and flowering plants will present an admirable example of what can be done with this sort of a garden.

No less important, though not on such a large scale, will be the new garden back of the old range of greenhouses and

surrounding the Linnean house. The brick and stone walls at this end of the Garden offer an admirable setting for an English garden effect, the use of trellises, small summer houses, and formal pools adding materially to its attractiveness.

While very far from showing the finished appearance towards which we are striving, the garden in the vicinity of the main gate has throughout the season presented a very much better appearance than it did last year, when the extensive changes in the walks and grades greatly retarded the planting. Many additions have been made to the shrubbery and herbaceous plants on the knolls, as well as to the borders of flowering annuals. Perhaps the best floral display in the main garden was obtained in the fall from nearly 40,000 cosmos plants, which produced a color effect rarely seen. This was at its height during the month of October, when the Garden had an unusual number of visitors from outside of St. Louis. Considerable space was also given up to a large collection of geraniums in order to test out the possibilities of these plants for outdoor bedding in St. Louis. Of the hundreds of varieties tried, a certain number have been selected for future experiments, and, while they will not again be extensively used in the main garden, there will continue to be grown some of the best varieties so that a demonstration may be made of the usefulness and attractiveness of this plant. The water garden between the main gate and conservatories was filled with lilies and other aquatics throughout the summer, and at times was the source of much favorable comment.

The most notable change which has been made within doors is the planting of the north wing of the new conservatory. The clay in this house was replaced with good earth, the benches removed and the heating pipes placed behind a retaining wall, as in the fern house. The collection of cycads, of which we have representatives of every genus, was never so well displayed, and the addition of certain conifers gives a Japanese-garden effect, which is quite different from that obtained in any of the other houses. In the fern house a considerable number of vines, together with hanging baskets, have improved the general appearance. The palm and economic houses have done remarkably well during the year, and the plants are beginning to show the effect of growing under the favorable conditions provided in these houses. The usual floral displays have been held in the south wing of the new conservatories during the fall, winter, and spring.

The new heating system has now been in service long enough to admit of some comparison with the old, as regards cost and efficiency. Previous to the building of the central heating plant and new conservatories there were about 695,000 cubic feet to heat. Fourteen separate fires were maintained for the purpose, and a considerable amount of the time of the gardeners had to be devoted to attending to these during the day. At no time was the system adequate — even when supplemented with oil stoves, for not only was the proper temperature not maintained, but in several of the houses the temperature occasionally fell to freezing or below. At the present time nearly 2,000,000 cubic feet are being heated (an actual increase of 1,304,806 cubic feet) at a cost for fuel of two and one-half times less per cubic foot than under the old system. Counting the interest on the investment and the increased cost for skilled labor, but taking into consideration the amount of heat now furnished, it appears that the new central heating plant is costing about one-half what would be necessary to maintain the old system of separate fires. There is of course no comparison in the efficiency and satisfaction obtained from the new over the old method.

ANNIVERSARY

The most notable event for the year, from many standpoints, was the celebration of the twenty-fifth anniversary of the organization of the Board of Trustees. An account of the exercises, together with the scientific program presented and a list of the out-of-town delegates present, has already appeared in the October number of the BULLETIN, and consequently no extensive notice need be given here. In addition to those papers which were read at the scientific sessions by the authors, there have been received papers from several foreign delegates who were prevented from being present at the celebration. These, with the papers read, will be printed in an anniversary number of the ANNALS to appear early in 1915.

SCHOOL OF GARDENING

As noted extensively in the April BULLETIN, the courses offered in gardening have been entirely reorganized and the scope of the school considerably enlarged. Owing to the unique opportunities at the Garden, it is believed that this school will soon take first rank with similar institutions throughout the world. There is nothing precisely like it in this country, for, although there are numerous institu-

tions which give a part of the work necessary for fitting young men and women to be competent gardeners and superintendents, there is no one place which so admirably combines theoretical instruction with facilities for practical experience as the Missouri Botanical Garden. The reunion of former garden pupils, together with the organization of an alumni association, has been sufficiently commented upon in the December BULLETIN.

ATTENDANCE

The total number of visitors attracted to the Garden continues to increase, although the excess of 1914 over 1913 is not so great as that of 1913 over 1912. The Sunday attendance for the year has fallen off, part of this being due to the fact that there were two more open Sundays (in March) in 1913, on which 10,765 people came to the Garden. In 1914 the open Sundays did not begin until April, and the hot, dry summer affected still further the number of Sunday visitors. May, June, and July of this year all showed a decrease over the previous year, nearly 6,000 fewer people coming to the Garden last June than in the corresponding month in 1913. It seems fair to assume that such a decrease was undoubtedly due to the weather, since all of the other months of the year, with the exception of March (for the reason above noted) and December, show substantial increases. The marked falling off in the December attendance is probably due in part to the bad weather, but there can be no question that the interruption of car service, due to the work on the Tower Grove viaduct, had a very discouraging effect upon any who may have wished to come to the Garden. The probabilities are, taking the experience of similar institutions under like circumstances, that with the transportation facilities at present available, the attendance at the Garden cannot be expected to increase materially beyond the present numbers.

In order that some idea might be obtained of the localities from which visitors to the Garden come, a system of voluntary registration was inaugurated on January 1, 1914, and continued throughout the twelve months. Less than 50 per cent of those coming to the Garden registered, but it is believed that the results obtained are fairly indicative of the various sources of visitors. While the number of foreigners constituted such a small fraction of the total number of visitors that it is hardly worth considering, it is interesting to note that last year people came to the Garden from Canada, Mexico, Cuba, Central America, East Indies, Great Britain,

Scotland, Ireland, Holland, Germany, Norway, Denmark, Switzerland, Spain, Persia, Liberia, India, Japan, Philippine Islands, Australia, Roumania, and the Island of Mauritius.

According to the registration cards, about 24 per cent of the visitors were from out of town, one-third of them coming from the State of Missouri, but every state in the Union being represented. It is probable that this percentage is somewhat higher than would have been the case had all registered, as it was noted throughout the year that those coming from outside the city were more apt to register than those living in St. Louis. Of the 76 per cent of the visitors who registered from the city, 60 per cent were from the south side, 25 per cent from the west side, 13 per cent from the north side, and 2 per cent from the east side.

ATTENDANCE FOR THE YEAR 1914

	Week-days	Sundays
January	2,124	.....
February	2,079	.....
March	5,177	.....
April	18,827	21,320
May	15,087	11,883
June	7,274	5,041
July	12,692	4,144
August	12,772	7,121
September	9,426	8,737
October	10,924	9,524
November	34,743	22,417
December	899	.....
	132,024	90,187
		132,024
Total		222,211

RESEARCH AND INSTRUCTION

The work of research during the year has exhibited a wholesome activity, very nearly reaching a point where it is limited only by the facilities at the disposition of the staff. In the last report the arrangements for segregating the different phases of investigation were referred to and comment was made upon the facilities offered. Since that time further progress has been made with respect to the installation of apparatus and materials for the experimental laboratory, including, particularly, apparatus needed in the chemical and pathological aspects of physiology.

During February and March there was installed in the floral display house, under the direction of Dr. Duggar, a

demonstration of some important relations of plants to lime and other soil nutrients. These experiments were designed to show the elements of the soil essential for plant growth, as well as the deleterious action of these same elements when not present in properly balanced proportion. The beneficial and harmful action of acid and alkali soils upon specific plants was likewise illustrated.

In the past a chief need has been that of a greenhouse set apart for laboratory work, in which experiments on a large scale might be carried out, especially in connection with plant nutrition and diseases. It is hoped that the new experimental greenhouses planned will be ready for occupancy by the fall of 1915. In the construction of these houses provision will be made whereby it may be possible in the future to install whatever apparatus is needed to accurately control humidity and temperature conditions. The control of these factors is a most important consideration in experimental work, and no modern greenhouse for the purpose would be complete without ultimately installing the apparatus mentioned.

As far as it may be possible it is the intention in the future to concentrate most of the effort of the laboratory upon some one main line of investigation, the work to continue through a period of years. Such an investigation with growing plants has not been feasible because the space for experimental work has been so limited.

Instruction, Lectures, etc.—Undergraduate courses offered during 1913-14 in the Henry Shaw School of Botany by members of the staff who are likewise members of the faculty of Washington University, were fourteen in number. These included two new courses: Special Chapters in Fermentation, by Dr. Duggar, and Plant Geography, by Dr. Greenman. The course in Morphology and Taxonomy of the Fungi has been assumed by Dr. Burt, and the course in General Botany by Dr. Schramm. In addition to those mentioned, the regularly announced courses were offered in Bacteriology, Morphology and Taxonomy of the Algae, Morphology and Taxonomy of the Spermatophytes, Advanced Physiology, Sanitary Bacteriology, Taxonomy, Seminar, and Research in several phases of botany.

Lectures or addresses by members of the staff include the following:

H. von Schrenk, December 17, 1913, before the Bell Telephone Club, St. Louis, "Decay and Preservation of Poles, and Maintenance of Telephone Lines".

W. W. Ohlweiler, January 12, before the Garden Club of Webster Groves, Missouri, "Garden Plans".

George T. Moore, February 17, before the Washington University Association, "Speculations Regarding the Origin of Life".

George T. Moore, February 20, before Town and Gown, "Botany and the Town".

H. von Schrenk, February 20, before the Young People's Union of the Ethical Society, "Trees and Modern Uses of Lumber".

H. von Schrenk, in March, before the Department of Forestry, University of Toronto, five lectures on "Diseases of Trees and Structural Timbers".

H. von Schrenk, March 10, before the Garden Club of Webster Groves, "Tree Planting and Diseases of Trees".

G. H. Pring, March 11, before the School of Social Economy of Washington University, "Evolution of the Chrysanthemum"; March 18, "Pollination of Plants".

W. W. Ohlweiler, April 6, before the Monday Club of Edwardsville, Illinois, "Home Gardens".

George T. Moore, April 13, in the Washington University Series, "Edible and Poisonous Mushrooms".

W. W. Ohlweiler, April 14, before the eugenics class of the School of Social Economy, Washington University, "Plant Development".

B. M. Duggar, April 15, before the Graduate Association of the Iowa Agricultural College, "The Vegetation and Plant Relations of Algeria and the Sahara".

B. M. Duggar, April 20, in the Washington University Series, "Mushroom Growing and Truffle Hunting".

C. H. Thompson, April 21, before the Science Section of the Wednesday Club, "Pests of Forest Trees".

J. M. Greenman, April 27, in the Washington University Series, "Our Native Wild Flowers".

H. von Schrenk, May 4, before the National Lumber Manufacturers' Association, in Chicago, "The Proper Uses of Lumber".

W. W. Ohlweiler, May 15, before the St. Louis Branch of the American Pharmaceutical Society, "A Modern Herbal Garden".

B. M. Duggar, June 1, before the Alumni Association of the Mississippi State College, "The Influence of Science".

W. W. Ohlweiler, October 9, before the Association of American Cemetery Superintendents, "Flower Displays Without Rain".

John Noyes, October 9, before the Association of American Cemetery Superintendents, "Pictures in a Park Cemetery".

George T. Moore, October 13, before the City Club, "The Relation of the Missouri Botanical Garden to the City".

George T. Moore, November 11, before the Sherman School Patrons and Teachers' Association, on the Garden and its activities.

W. W. Ohlweiler, November 19, before the Missouri Botanical Garden Students' Club, "Introduction of Tropical Plants".

J. R. Schramm, November 24, before the Indiana Apple Show, "The Apple Plant in Health and in Disease".

G. H. Pring, December 7, before the Missouri Botanical Garden Students' Club, "The Garden Collection of Orchids".

C. H. Thompson, December 8, before the Girls' Self Culture Club of the St. Louis Settlement Association, an illustrated talk on the Garden.

B. M. Duggar, December 13, before the Gamma Alpha (graduate) fraternity of the University of Illinois, "In Scientific Training What Constitutes Breadth?"

H. von Schrenk, December 21, before the Academy of Science of St. Louis, "The Modern Uses of Lumber".

Publications and Papers.—The following articles by members of the staff or of the graduate laboratory have appeared since the publication of the last report, and furnish one of the tangible evidences of the activity of the research work carried on at the Garden:

Duggar, B. M., and Cooley, J. S. "The Effects of Surface Films and Dusts on the Rate of Transpiration". Ann. Mo. Bot. Gard., No. 1, 1914.

Duggar, B. M., and Merrill, M. C. "The Effect of Certain Conditions upon the Acidity of Tomato Fruits". Ann. Mo. Bot. Gard., No. 2, 1914.

Duggar, B. M., and Cooley, J. S. "The Effects of Surface Films on the Rate of Transpiration: Experiments with Potted Potatoes". Ann. Mo. Bot. Gard., No. 3, 1914.

Duggar, B. M. "Physiology and Ecology". American Yearbook, 1914.

Duggar, B. M., and Davis, A. R. "Enzyme Action in Fucus vesiculosus". Ann. Mo. Bot. Gard., No. 4, 1914.

von Schrenk, H. "Two Trunk Diseases of the Mesquite". Ann. Mo. Bot. Gard., No. 2, 1914.

von Schrenk, H. "A Trunk Disease of the Lilac". Ann. Mo. Bot. Gard., No. 2, 1914.

Greenman, J. M. "Descriptions of North American Senecioneae". Ann. Mo. Bot. Gard., No. 3, 1914.

Greenman, J. M., and Thompson, C. H. "Diagnoses of Flowering Plants, Chiefly from the Southwestern United States and Mexico". Ann. Mo. Bot. Gard., No. 4, 1914.

Burt, E. A. "The Thelephoraceae of North America. I." Ann. Mo. Bot. Gard., No. 2, 1914.

Burt, E. A. "The Thelephoraceae of North America. II. Craterellus". Ann. Mo. Bot. Gard., No. 3, 1914.

Burt, E. A. "The Thelephoraceae of North America. III. Craterellus borealis and Cyphella". Ann. Mo. Bot. Gard., No. 4, 1914.

Schramm, J. R. "Some Pure Culture Methods in the Algae". Ann. Mo. Bot. Gard., No. 1, 1914.

Schramm, J. R. "A Contribution to our Knowledge of the Relation of Certain Species of Grass-Green Algae to Elementary Nitrogen". Ann. Mo. Bot. Gard., No. 2, 1914.

Cooley, J. S. "A Study of the Physiological Relations of Sclerotinia cinerea (Bon.) Schröter". Ann. Mo. Bot. Gard., No. 3, 1914.

Foster, G. L. "Indications Regarding the Source of Combined Nitrogen for Ulva Lactuca". Ann. Mo. Bot. Gard., No. 2, 1914.

Nolte, August G. "The Identification of the Most Characteristic Salivary Organism and its Relation to the Pollution of Air". Ann. Mo. Bot. Gard., No. 1, 1914.

Overholts, L. O. "The Polyporaceae of Ohio". Ann. Mo. Bot. Gard., No. 1, 1914.

Vaughan, R. E. "A Method for the Differential Staining of Fungous and Host Cells". Ann. Mo. Bot. Gard., No. 2, 1914.

Also the following publications during 1913-14 by those newly appointed to Rufus J. Lackland fellowships:

Studhalter, R. A. (with Heald, F. D.) "The Strumella Disease of Oak and Chestnut Trees". Pa. Dept. For. Bull., 1914.

Studhalter, R. A. (with Heald, F. D.) "Birds as Carriers of the Chestnut-blight Fungus". Journ. Agr. Res., 1914.

Studhalter, R. A. (with Heald, F. D., and Gardner, M. W.) "Air and Wind Dissemination of the Chestnut-blight Fungus, *Endothia parasitica* (Murr.) And." Journ. Agr. Res. (in press).

Studhalter, R. A., and Ruggles, A. G. "Insects as Carriers of the Chestnut-blight Fungus". Pa. Dept. Forestry Bull. (in press).

Zeller, S. M. "The Development of *Stropharia ambigua*". Mycologia, 1914.

Zeller, S. M. "The Development of *Ceriomyces Zelleri*". Mycologia, 1914.

Zeller, S. M. (with Frye, T. C.) "The Morphology of *Urospora tetraciliata*, sp. nov." Puget Sound Marine Station, Bull. (in press).

Zeller, S. M. (with Neikirk, A.) "The Gaseous Exchange in the Pneumatocyst of Nereocystis leutkeana". *Ibid.* (in press).

At the winter meeting of the American Association for the Advancement of Science and affiliated societies, Philadelphia, December 29, 1914, to January 2, 1915, the following papers were presented by members of the staff and graduate students:

J. M. Greenman, before the Bot. Soc. of Am., "Morphology as a Factor in Determining Genetic Relationship".

A. R. Davis, before the Bot. Soc. of Am., "Enzymes of the Marine Algae".

J. C. Gilman, before the Phytopath. Soc., "The Relation of Temperature to the Infection of Cabbage by *Fusarium conglutinans* Wollenw".

M. C. Merrill, before the Bot. Soc. of Am., two papers, "Electrolytic Determination of Exosmosis from the Roots of Anaesthetized Plants" and "Some Relations of Plants to Distilled Water and Certain Dilute Toxic Solutions".

R. A. Studhalter (with F. D. Heald), before the Am-Phytopath. Soc., "Desiccation of Pycnospores and Ascospores of *Endothia parasitica* under Artificial Conditions".

The papers just mentioned will appear only in abstract in the proceedings of the societies before which they are presented, and these together with other work in progress will be published in full in the ANNALS during 1915.

Graduates and Fellows.—M. C. Merrill, who was reappointed research assistant, is continuing his work in this capacity, and at the same time is prosecuting studies leading toward the doctorate. The following are the 1914 appointments to the Rufus J. Lackland fellowships: A. R. Davis, A.B. Pomona College, Calif., reappointed third year; L. O. Overholts, A.B. Miami University, reappointed third year; G. W. Freiburg, B.S. South Dakota Agricultural College (formerly assistant in botany and graduate student, University of Missouri); J. C. Gilman, B.S. University of Wisconsin (formerly assistant in pathology, University of Wisconsin); R. A. Studhalter, A.B. University of Texas (formerly assistant in forest pathology, Bureau of Plant Industry, Department of Agriculture); and S. M. Zeller, special research assistant Yellow Pine Association, A.M. University of Wash-

ington (formerly instructor in botany at the University of Washington).

In addition to the graduates mentioned in the preceding paragraph, others who have pursued studies in the Graduate Laboratory as candidates for advanced degrees in Washington University, or elsewhere, during the calendar year are as follows: J. S. Cooley (formerly Rufus J. Lackland fellow); W. H. Emig (formerly Rufus J. Lackland fellow); E. C. Ewing, M.A. Cornell University (at present assistant agronomist, Miss. A. & M. College); G. L. Foster (formerly teaching fellow in Washington University); H. H. Shackleford, B.S. University of Missouri; R. L. Vaughan, B.S. University of Wisconsin (exchange fellow from the University of Wisconsin); F. B. Wann, A.B. Wabash College (at present teaching fellow, Washington University).

Graduates who have terminated their connection with the laboratory during the year are as follows: G. L. Foster, formerly teaching fellow in Washington University, appointed assistant in physiological chemistry, Harvard Medical School; W. H. Emig, formerly Rufus J. Lackland fellow, appointed instructor in botany, University of Oklahoma; and J. C. Cooley, formerly Rufus J. Lackland fellow, appointed assistant pathologist, Bureau Plant Industry, U. S. Department of Agriculture.

The facilities of the graduate and research laboratories are freely extended to visiting botanists and to other persons qualified by training and experience to carry on investigations in botanical science. Under this provision several botanists have taken advantage of the opportunities which the laboratories, library and herbarium offer; and those who have remained for a term, or a considerable part of a term, are as follows: M. J. Dorsey, Ph.D., Professor of Horticulture at the University of Minnesota, investigating relation of plants to temperature; R. R. Gates, Ph.D., Lecturer in Botany, University of London, studies in heredity; Lewis Knudson, Ph.D., Assistant Professor in Charge of Plant Physiology, Cornell University, investigating particularly the relation of seed plants to organic nutrients.

Research in Progress.—Below is given an indication of some of the problems now being investigated by members of the scientific staff and graduate students:

E. A. Burt. A critical study of the higher fungi of North America, including their distribution and an attempt to correlate known forms with the imperfect description of pioneer mycologists. A monograph of the Thelephoraceae is in process of publication.

B. M. Duggar. The action of the salts of aluminum on plant growth and the ameliorating value of various nutrients. Mineral nutrient relations as affecting the turgor of plant cells.

J. M. Greenman. A monograph of the North American species of Senecio. Study of the material obtained by the collector and others with reference to the contemplated publication of a flora of the Southwest.

M. C. Merrill. Studies of the changes in solutions in which plants are growing, due to the action of anaesthetics and other factors. Some indications respecting the nature of distilled water injury to plants and the recovery therefrom.

George T. Moore and J. R. Schramm. The precipitation of lime by algae and the bearing of this process upon travertine and other similar formations. A peculiar root nodule organism. New or little known algae.

E. J. Palmer. A catalog of the plants of Jasper County, Missouri.

J. R. Schramm. The relation of certain species of grass-green algae to elementary nitrogen in the presence of combined nitrogen. The nature of permeability in collodion membranes.

H. von Schrenk. Investigation of the decay of wood. Tests as to the efficiency of various wood preservatives and fireproofing paints, the chief point under investigation dealing with the relationship between the chemical composition of the various preservatives and their effect on a number of the principal wood-destroying fungi.

C. H. Thompson. A revision of the North American species of Scutellaria. A synoptical revision of the genus Schrankia.

A. R. Davis. A general study of enzyme action in marine algae, or an endeavor to get indications regarding certain phases of the nutrition of these forms.

M. R. Ensign. Physiological conditions affecting spore germination in mushrooms.

G. W. Freiberg. Conditions affecting the inception of plant diseases.

J. C. Gilman. A study of the biological relations of the yellows disease of cabbage.

L. O. Overholts. A critical study of the polypores, especially those of Missouri. This includes many of the more destructive of the timber-decay fungi.

R. A. Studhalter. The capacity of certain spores, especially those of disease-producing fungi, to resist drying conditions.

S. M. Zeller. Relation of resins and other products in pine wood to the growth of destructive fungi in such timber.

HERBARIUM

During the year certain improvements have been made in the herbarium, notably the installation of several wall cases of steel construction which conform with those already in use. These additional cases now fully equip the second floor herbarium-room with metal cases and give adequate protection to the specimens against the possibility of damage by fire or dust, to which they are always more or less subject in the ordinary wooden case. These cases, moreover, furnish the space needed for expansion in this part of the herbarium. Quarters have been provided in the gallery of the museum building for the parasitic and fleshy fungi; and these groups are now being critically studied and thoroughly organized by Dr. Burt. The transfer renders available several cases on the third floor of the main building and will give opportunity to relieve the crowded conditions among some of the families of the seed plants. These changes have involved a shift of a large part of the collection, but they provide the necessary room for interpolation of new material during the coming year. Rooms for storage of unorganized and duplicate material, for sorting and mounting of specimens, have been furnished in the old residence.

New Accessions.—The most important accession to the herbarium during the past year is the acquisition by purchase of the private herbarium of Mr. Ernest J. Palmer. It contains upwards of 5,000 specimens, about nine-tenths of which are from Jasper County, Missouri, and the balance are mainly from neighboring counties in the southwestern part of the State. The collection represents the botanical work of Mr. Palmer during the twelve years from 1901 to 1913. Special sets of *exsiccata,* illustrating the flora of different parts of the world, have been purchased; several valuable series of plants have been secured by exchange; a number of collections have been obtained by gift; and a relatively large amount of valuable material has been acquired through field work. The more noteworthy accessions are the following: A. Alexander, plants of Michigan; Arnold Arboretum, ligneous plants of North America; J. C. Arthur, fungi from Mexico and Central America; E. Bartholomew, "North American Uredinales," centuries IX, X, and XI, Nos. 801-1100, and "Fungi Columbiani," centuries XLIII, XLIV, and XLV, Nos. 4201-4500; H. H. Bartlett, plants of the Southern States; W. E. Broadway, plants of Tobago, W. I.; B. F. Bush, plants of Missouri; J. R. Churchill, plants of Colorado and Massachusetts; I. W. Clokey, plants of Canada and Illinois; F. S. Collins, "Phycotheca Boreali-

Americana," Fasc. XL, Nos. 1951-2000; Rev. John Davis, plants of Missouri; C. C. Deam, plants of Indiana; J. A. Drushel, plants of Alabama, Missouri, and Ohio; A. D. E. Elmer, plants of the Philippine Islands; W. G. Farlow, fungi from New England, Cuba, and Jamaica; K. W. Krieger, "Fungi Saxonici exsiccati," Fasc. XLVI, Nos. 2251-2300; A. O. Garrett, "Fungi Utahensis," Fasc. IX, Nos. 201-225; J. M. Greenman and C. H. Thompson, plants of Missouri; A. A. Heller, plants of California; F. Hemm, plants of Kansas; H. D. House, fungi of New York; A. M. Huger, plants of North Carolina and Georgia; C. J. Humphrey, fungi chiefly of the Western States; E. L. Johnston, plants of Colorado; J. Kellogg, plants of Missouri; O. Leonhardt, general collection of fungi; H. D. Macoun, plants of Canada; L. Matthews, plants of Missouri; E. O. Matthews, plants of Missouri, Texas, and Mexico; New York Botanical Garden, plants of the West Indies; New York State Museum, specimens of fungi; North Dakota Agricultural College, plants of North Dakota; L. O. Overholts, plants of Colorado; E. J. Palmer, plants of Missouri, Arkansas, and Texas; L. H. Pammel, plants of Colorado; C. A. Purpus, plants of Mexico; A. B. Seymour, fungi of New England; F. C. Seymour, plants of Massachusetts; H. Sudre, "Batotheca Europaea," Fasc. XI and XII, Nos. 500–600, and "Herbarium Hieraciorum," Fasc. V and VI, Nos. 201-300; R. Thaxter, fungi of Florida; C. H. Thompson, cultivated plants; U. S. Nat. Museum, "American Grasses," Nos. 1-200, and plants of Texas and New Mexico; University of Pennsylvania, Scrophulariaceae of the Southern States; University of Texas, plants of Texas; S. S. Visher, plants of Alaska, British Columbia, and Washington; H. von Schrenk, fungi of the United States, West Indies, and Austria; A. von Hayek, "Centaureae exsiccatae criticae," Fasc. I and II, Nos. 1-100; G. Zenker, plants of Kamerun, centuries IV and V, Nos. 400-499; and J. R. Wier, fungi of Idaho. A complete list of the accessions received during the year has been recorded in the monthly issues of the BULLETIN.

Mounting and Distribution.—The mounting of herbarium specimens has continued throughout the year; and the greater part of the material received on new accessions has been already incorporated in the general herbarium. In addition to this, the F. Blanchard herbarium and the J. M. Greenman herbarium have been fully organized and a complete series from each collection has been mounted and the duplicates laid out in sets ready for distribution to correspondents on the basis of exchange. A relatively small number of duplicates has been sent out during the year in ex-

change, but several thousand specimens are ready to distribute to American correspondents. Exchanges with foreign institutions, however, seem best deferred until more stable conditions are brought about and the safe delivery of packages to European herbaria assured.

Field Work.—In continuation of the coöperative field work with the Arnold Arboretum which was begun last year, the object of which is to obtain a more complete representation of the plants indigenous to the Southwest with the view of eventually publishing a flora of this region, Mr. Ernest J. Palmer spent the months of April, May, June, and July in Southeastern Texas, in Arkansas, and in Southwestern Missouri. During this time, collections were made in Texas at Matagordo, Brazoria, Columbia, Wharton, Eagle Lake, Livingston, and Marshall; in Arkansas at Fulton, Eureka Springs, and Corning; in Missouri at Noel, Galena, Branson, Joplin, Alba, Mansfield, Van Buren, Williamsville, and Des Arc. Most of these stations were visited again in the autumn in order to secure the late flowering plants and fruiting specimens of the vernal flora. During the latter part of the season collections were also made at Cleveland, Osage, McAlester, and Tishomingo, Oklahoma; at Granbury, Texas; and at Harrison, Jaspar and Heber Springs, Arkansas. The material secured by Mr. Palmer is now being laid out in sets and labelled ready for critical study. Field work has also been carried on in Northeastern Missouri by Rev. John Davis, who was commissioned by the Garden to collect plants during the season from April to October. From Mr. Davis the herbarium has received a collection of plants admirably representing the flora of Hannibal County. The collection also contains a relatively large number of duplicate specimens which are valuable for exchange purposes.

Use of the Herbarium by Outside Botanists.—The number of visiting botanists making direct use of the herbarium this past year is considerably larger than in the previous year. Numerous small loans of herbarium material in particular plant groups have been made to specialists for the purpose of comparison and monographic studies. Requests for the identification of plants are constantly increasing; and frequently very interesting and scientifically valuable specimens are obtained in this manner.

Statistical Summary: (For the year ending December 31, 1914).

Number of specimens acquired:

By purchase	**13,919**
By gift	**2,636**

By exchange	1,834
By field work	12,318
	30,707

Number of specimens mounted and incorporated:

From Blanchard herbarium	1,649
From Greenman herbarium	4,651
From all other sources	16,267
Total	22,567

Number of specimens discarded from the herbarium, 997.
Number of specimens in organized herbarium, 657,461.

LIBRARY

In order to make more accessible and useful the periodicals in the library, a start has been made in preparing a subject index of the titles of the botanical articles published by the scientific societies of the world, as well as an author's index of the same. The arrangement of the cards in such a subject index is of the highest importance in order that the index may quickly direct the one consulting it to all the information on the particular topic of inquiry. The details of arrangement of the cards are now being worked out by members of the scientific staff of the Garden, who are also to classify the cards to be prepared in the future.

The Annals of the Missouri Botanical Garden, issued quarterly, is the principal exchange for the publications of scientific institutions and societies, as was the old Annual Report. This brings to the library many publications which could not be obtained otherwise, and promises to be increasingly useful in the future. It is computed that the value per year of the exchanges received for the ANNALS is $1,335.00. A few important publications are also received for the BULLETIN.

A number of the leaflets, pamphlets, and books which were shown missing from their allotted places by the library inventory of 1913, have been located out of place during the present year. The list of entries at present missing, but which we hope to lessen further, is 237, of which 46 per cent are leaflets such as might be used by students of horticulture, 18 per cent are leaflets of ephemeral interest, and the remainder are largely separates of botanical articles. The total number missing at present is about thirty-two hundredths of 1 per cent of the whole number of pieces in the library, or about one and one-third hundredths of 1 per cent per year for the time the library has been in existence. This is a very low record of misplacement and loss for any

library—especially low for a library whose stacks are directly accessible to students and scientific visitors.

The European war has cut off most transactions with foreign book markets and temporarily prevents the acquisition of lacking volumes to complete several important sets, arrangements for which had been made.

There have been 683 volumes, valued at $1,348.90, and 1,359 pamphlets, valued at $212.45, donated to the library; and 389 volumes, valued at $1,700.39, and 40 pamphlets, valued at $41.60, were purchased. There were also donated six manuscripts, valued at $5.25, and two maps, valued at $0.60. A total of 12,257 index cards have been added, 1,935 of which were written by garden employees, and 10,322 purchased at a cost of $131.00. The number of books bound was 750.

ANNUAL BEQUESTS

The flower sermon, provided for in Mr. Shaw's will, was preached in Christ Church Cathedral by the Rev. A. A. V. Binnington, of Lebanon, Pennsylvania, on May 16, 1914.

The Twenty-Fifth Gardeners' Banquet was held on the evening of November 27, 1914, at the University Club. Professor J. C. Whitten, of the State University, Professor A. T. Erwin, of Ames, Iowa, and Mr. Arthur R. Gross, of Chicago, made short speeches on the organization of the Missouri Botanical Garden Alumni Association.

The Trustees' Banquet was held on the evening of October 16, 1914, at the Liederkranz Club, and marked the close of the exercises in connection with the celebration of the Twenty-Fifth Anniversary of the organization of the Board of Trustees. The banquet was attended by many distinguished guests from all parts of the United States, as well as by foreign delegates.

Respectfully submitted,

GEORGE T. MOORE,
Director.

STATISTICAL INFORMATION FOR DECEMBER, 1914

GARDEN ATTENDANCE:

Total number of visitors	899

PLANT ACCESSIONS:

Total number of plants received in exchange	28
Total number of plants and packets of seeds donated	26

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	7
Total number of books and pamphlets donated	256

HERBARIUM ACCESSIONS:

By Purchase —

M. Gandoger—Plants of Europe	3,497
A. J. Grout—"North American Musci Pleurocarpi," Nos. 426-450	28
R. von Münchausen — Plants of Europe (Jeppe's "Herbarium Vivum")	50

By Gift —

J. A. Drushel—Plants of Alabama, Michigan, and Missouri	7
W. H. Emig—Plants of Oklahoma	7
C. E. Owens—Fungi from Oregon	9
E. E. Sherff—Photographs of *Bidens*	4

By Exchange —

J. E. Kirkwood—Plants of Montana	100
University of California—*Senecio kermesinus* Hemsl. from Mexico	1

By Field Work —

E. J. Palmer—Plants of Missouri, Arkansas, and Texas	8,142
TOTAL	11,845

The Garden is open to the public week days the year 'round from 8:00 A. M. until one-half hour after sunset. Admission free. Beginning with the first Sunday in December and continuing until April 4, the Garden is closed Sundays.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

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MISSOURI BOTANICAL GARDEN BULLETIN

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THE CARE OF HOUSE PLANTS

Failure frequently attends the attempt to grow plants in the home. The same may be said, in many cases, of the growing of plants out of doors during the summer months. In each case failure is probably due to a lack of sufficient knowledge regarding the requirements of plants, whether in or out of doors, although, in general, it is considered far more difficult to grow and care for plants in the home than out of doors. There can be no question that the conditions in the home are ordinarily unfavorable for both the growing of plants and the preservation of flowers, and the following account is intended to point out the usual causes of failure, and to indicate in a general way the plants and flowers best adapted for the home during the winter months.

IMPORTANT ENVIRONMENTAL FACTORS

Light.—The foods, from which plants derive the necessary materials for growth and energy for the various life processes, are manufactured in large part in the green parts under the influence of sunlight. In the absence of sufficient light this process of food synthesis is retarded, and, if the light is sufficiently reduced may even be brought to a standstill. Moreover, an inadequate supply of light may result in a partial or total loss of the green pigment, so essential in the manufacture of food, rendering the leaves white or light green. In the house, especially at some distance from the windows, this loss of green coloring matter may become very pronounced in some plants although scarcely noticeable in others, but in either case the manufacture and storage of food is usually more or less reduced, in time frequently resulting in the decline and ultimately the death of the plant. As already intimated, plants differ as regards tolerance of diminished light, but even so it should be a general practice to move house plants near the window or directly into the sunlight for at least a few hours each day.

Temperature.—This is an important factor in plant growth and is usually subject to considerable variation in the home. It is a popular belief that most, if not all, plants do better when the temperature is lower during the night than during the day, a condition which usually obtains in greenhouses, and normally in the home. Plants vary considerably in their temperature requirements, some failing to grow at temperatures much above 60°F. House temperatures ordinarily run considerably higher than this, and, in fact, are high enough during the day for the growing of tropical plants. It is obviously impossible to regulate the temperature of the house exclusively to suit the needs of the plants. It is, therefore, necessary to choose such plants as will tolerate the temperatures ordinarily obtaining in homes. The attempt to grow plants at temperatures above their optimum growth temperatures is a common cause of failure. As regards systems of heating, hot-water is probably the most satisfactory for growing plants in the house, because it has less tendency to produce an excessively dry atmosphere and great and abrupt changes in temperature.

Humidity.—The methods ordinarily used in heating houses tend to make the atmosphere excessively dry, and unless some provision is made for raising the humidity of the air, plants frequently wilt and ultimately die. Where many plants are kept together, as in the bay-window or house-conservatory, the tendency is to raise and stabilize the humidity of the air by the moisture constantly being given off from the plants and the soil. But where this is not the case, it is necessary to increase the moisture content of the air, either by periodically spraying the plants, placing vessels of water on the radiator or elsewhere near by, or by keeping sphagnum moss—saturated with water—on the surface of the pots.

Injurious Gases.—Certain constituents of illuminating gas are—even when present in very small quantities—extremely poisonous to plants, and unquestionably are frequently the cause of injury to plants in the house. The amount of these gases escaping in small and unnoticed leaks, as well as in lighting and turning off gas flames, is doubtless sufficient to cause appreciable injury. It has, for instance, been shown that one part illuminating gas in 40,000 parts of air is sufficient to prevent carnation buds from opening, whereas exposure for three days kills the young buds. Subjecting carnations for twelve hours to an atmosphere containing one part illuminating gas in 80,000 parts of air causes all flowers to close. It has further been demonstrated that one part of ethylene—a constant constituent of illumin-

ating gas—in one million parts of air causes the flowers to close. Especial care should therefore be taken to prevent as much as possible the escape of illuminating gas, whether from leaks or careless lighting. Good ventilation will doubtless tend to minimize the injury from poisonous gases, but in providing it, it should be remembered that many plants are extremely sensitive to sudden chilling.

Water.—Perhaps no one factor is so important in the successful growing of plants in the house as is proper watering. Owing, however, to the striking differences between the various kinds of plants as regards water requirements, as well as the differences in temperature, soil, humidity, etc., to which plants are subjected in houses, it is practically impossible to give general directions which will be fundamentally helpful. Practical experience alone, it seems, can teach one the proper use of water for house plants. With the exception of certain desert plants, like the cacti, most plants thrive best in a thoroughly moist soil, and are injured by even slight degrees of wilting. It appears, however, that over-watering rather than under-watering is the more frequent cause of failure. While most plants require a thoroughly moist soil, a muddy or water-logged soil is in most cases distinctly injurious. Such a condition can be effectively avoided by providing ample drainage. But even where flower pots provided with drainage openings are used the common practice of placing the pots in turn in a jardiniere without drainage provisions leads to disaster. As water drains out at the bottom of the pot, it accumulates in the jardiniere, and, if enough is given, may accumulate to such an extent as to more than saturate the soil with water. Where jardinieres or other vessels without drainage facilities are used, great care should be taken to prevent over-watering. It is in all cases better to use shallow under pans, since the latter will overflow before an injurious amount of water accumulates in the soil, as so frequently occurs where jardinieres are used. If the latter are desired, a form provided with shallow under pans and having provision for drainage should be used.

As regards the frequency of watering, again no definite recommendation can be made. Usually it is not necessary to water house plants every day. Best results seem to be obtained by thorough waterings at longer intervals. In this connection it should be remembered that growing plants need a great deal more water than do dormant ones, flowering plants especially requiring large quantities of water for the full development of blossoms. It is further desirable in many plants to spray or even wash the leaves in order to

remove dust and soot which so frequently accumulates on the leaves, to the injury of the latter. This practice besides being beneficial greatly improves the appearance of the plants.

Insect and Fungous Diseases.—Of these two classes of plant diseases, only the former, the insect diseases, are ordinarily of much importance in the home; conditions in the house are not usually favorable for the development of fungous diseases. Insects injurious to plants may, however, multiply rapidly under the conditions ordinarily obtaining in houses, and cause serious injury to a great variety of plants. Among the most troublesome are the so-called scale insects attacking palms, ferns and many other plants. While there are many species of scale insects attacking plants, those usually infesting house plants are quite large, looking like miniature tortoises or footless lady-bugs tightly adhering to the surface of the leaves. Owing to the armor-like protecting layer over the scales, the latter are not readily killed by the ordinary mild insecticides. Control is most easily effected by scraping or brushing off the insects, after which the leaves should be washed with alcohol or soap and water, and thoroughly rinsed in cold water. Plant lice or aphids are another frequent source of trouble, and should be watched carefully because of the amazing rapidity with which they multiply. Tobacco liquid, which may be obtained from florists under a variety of trade names, will usually free plants from these pests. The liquid is best applied in the form of a fine spray. Other injurious insects of house plants are usually of such size that they can be best controlled by the simple expedient of picking them off and destroying them.

PLANTS TO GROW

For success in growing plants indoors much depends on the proper choice of varieties. As might be concluded from what has been said, plants which can be grown successfully in the average house must, in general, be such as can endure a dry atmosphere, usually a high temperature, and frequently inadequate light. The plants which most nearly meet these unusual requirements are certain tropical forms with more or less thick, leathery leaves like the palms, rubber plants, etc. —plants ordinarily classed as foliage plants. Among the large number of palms useful as indoor foliage plants, the following may be mentioned as among the best: *Phoenix Roeblinii, Cocos Weddelii, Corypha australis, Chamaerops humilis, Rhapis flabelliformis, Kentia Belmoreana, K. Noresteriana, Phoenix Rupicola, Seaforthia elegans, Areca lutescens,* and *Latania Bourbonica*—one of the fan palms.

Cycas revoluta, the so-called "sago" or "funeral palm," while not a true palm, is a useful house plant. Among the serviceable and attractive foliage plants should be mentioned the screw pines (Pandanus), chlorophytums, "leopard" or "gold dollar plant" (*Farfugium grande*), dracaenas, araucarias, or Norfolk Island pines, silk oak (*Grevillea robusta*), English ivy, sweet olive (*Olea fragrans*), century plant (*Agave americana*), *Phormium tenax,* umbrella plant (*Cyperus alternifolius*), *Papyrus antiquorum,* lemon verbenas, pepper plants, and aspidistras. Ferns doubtless constitute one of the most attractive classes of foliage plants and despite their usually very delicate appearance, many of them can be grown successfully in the house. The following are recommended: *Nephrolepis Whitmanni, N. Scotti, N. Scholzeli, N. Elmsfordi,* and *N.* "Roosevelt." The Boston fern, and the many varieties derived from it, nearly always do well in the house, and under particularly good conditions, even the more tender varieties succeed.

Except where unusually favorable conditions can be provided, as in a conservatory, considerable difficulty is usually encountered in growing and bringing into blossom flowering plants. More frequently such plants are obtained elsewhere and are brought into the house from time to time when in bud or in flower and thus made a part of the window garden only during their respective flowering seasons. But despite the frequently poorer results, it is highly desirable to grow flowering plants to maturity in the house because of the pleasure derived from watching day by day the process of gradual development. Among the plants which may be more or less successfully grown and flowered in the house may be mentioned begonias, camellias, rose mallows (*Hibiscus sinensis*), fuchsias, geraniums, heliotrope, petunias, callas, primroses, snapdragons, cyclamen, daisies, impatiens, abutilons, thunbergias, stocks, and verbenas. While many of these can be grown directly from the seed it is perhaps advisable in most cases to obtain the young plants from growers. In addition, many plants, such as poinsettias, Lorraine begonias, azaleas, chrysanthemums, freesias, ixias, oxalis, euphorbias, lily-of-the-valley, tulips, narcissus, etc., may be obtained when in bud, but long before the color in the flower is apparent, and matured in the house, provided proper care is given them.

Some of the plants which are frequently killed by frost when in the prime of their flowering season can be potted and brought into the house prior to frost injury and maintained in a blossoming condition for weeks after those remaining out of doors have been killed. Among these may

be mentioned salvias, lobelias, alyssum, candy-tuft, geraniums, nasturtiums, etc., as well as many foliage plants.

SPECIAL POINTS IN THE CARE OF HOUSE PLANTS

Owing to the varied requirements of different plants, it is quite impossible to give accurate directions covering even approximately all cases. A few points, however, such as repotting, resting period, and cutting-back should be mentioned, as failure to take these into account frequently leads to unsatisfactory results, or, in some cases, even failure.

Resting Period.—Many plants used in the house, especially bulbous and tuberous-rooted plants, require a period of rest following the growing season. Such plants, e.g., tulips, callas, hyacinths, narcissus, lilies, etc., following the flowering period should be given the most favorable growing conditions in order to afford the plants an opportunity to replenish the food materials in the bulbs which were utilized during the flowering period. Following this, the water should be withheld and the bulbs allowed to dry and "ripen." Bulbs treated in this way and prevented from shriveling by placement in sand in a cool, dry place, can be used for flowering purposes the following season. Not alone bulbous plants, however, are benefited by such a rest period, but practically all perennial flowering plants whose growth is discontinuous, i. e., those which show a cessation of growth following flower and seed production. Careful observation will readily enable one to determine whether plants should be given a rest period or not. Practically all bulbous plants, as well as tuber begonias, gloxinias, poinsettias, and many others are greatly benefited by a rest period. In order to bring the plants back into active growth, it is only necessary to supply them with sufficient water; ordinarily it is desirable to repot in fresh soil at the beginning of the new growing season.

Cutting Back.—House-grown plants tend to grow slender and weak because of the usually inadequate and unequally distributed light. By cutting back some of the leading shoots, new growths will usually start from below and tend to produce a bushier and sturdier plant. It is precisely in this way that growers obtain stocky pot-grown plants, as illustrated by snapdragons, begonias, etc. On the other hand, the removal of all side shoots and buds tends to make the main axis very strong and the remaining flower buds of greater size and better shape, a procedure the results of which are admirably illustrated in the long-stemmed, single-flowered chrysanthemums. The method of cutting-back to be used, therefore, depends largely upon the nature of the plants and the effect and results desired. The cutting-back

or pruning of woody perennial plants, such as roses, presents new problems, but these need not be entered upon here, as few plants of this class are ordinarily grown in the house.

Repotting.—Plants grown in pots for long periods of time finally become "pot-bound," i. e., the roots become crowded, making it necessary to transfer the plants to fresh soil in somewhat larger containers. If the plant with the ball of soil adhering to the roots is removed from the pot by inverting the latter and tapping gently, on a surface, the condition of the plant can be readily determined without injury to the latter. If the roots are plentiful around the outside of the ball of earth it is an indication that repotting is necessary. It should be remembered, however, that it is, generally speaking, not advisable to repot the plants after the flower buds have appeared, as the disturbance is usually sufficient to cause a retardation in the time of flowering as well as stunting the flowers themselves. In these cases it is better to leave the plant undisturbed, and as a substitute for repotting, supply the roots with liquid cow manure, which may be obtained from florists. Beneficial results will be obtained from this fertilizer, whether plants are pot-bound or not, if applied just prior to the flowering period. In repotting, the plant with the adhering ball of soil should be removed to a somewhat larger pot, the additional space being filled with fresh, rich soil. In general it is advisable to shift plants at shorter intervals into somewhat larger pots rather than into much larger ones at longer intervals. When plants are freshly potted in the fall just before bringing them into the house, it will usually not be necessary to repot before the following spring. The whole matter of repotting is so important that unless one is thoroughly familiar with the details, it is advisable to have it done by a competent florist or to do it under his direction. This is especially true since the method used is different for different plants, involving also the proper choice of soils.

GERANIUMS

In the June, 1914, number of the BULLETIN, announcement was made of an extensive test of geranium varieties with a view to adding, if possible, new desirable varieties to the small list of those at present known to be suited to growing in St. Louis and vicinity. In this experiment 367 varieties were included, careful observations on which were kept during the last season, especially as regards heat and drought resistance, profusion of flowers, color, shape, and size of flower clusters, character of foliage, etc. Although

last season was exceptionally dry and hot—conditions which are not at all favorable to the growing of many varieties of geraniums, favorable growth and satisfactory flower production has been recorded for 76 (a list of which is here appended) out of the 367 varieties tested. For convenience, the classification and sequence of the varieties as here given is the same as in the June, 1914, number of the BULLETIN.

BRUANT'S 1911 NOVELTIES

Caruso (d)[1]
Jeanne Girard (d)
Maxence (d)
Euripide (s)
Marcienne (s)
Comte F. De Rouge (d)

LEMOINE'S 1911 NOVELTIES

Felicien Champsaur (s)
Henri Ardel (s)

BRUANT'S 1910 NOVELTIES

Pierre Courtois (s)
Pierre Suhau (d)
Francis Eon (s)
Odol (s)
Chastenet de Castaing (s)

ROZAIN-BOUCHARLAT 1910 NOVELTIES

Diales (d)
Felician Pascal (s)

RECENT INTRODUCTIONS FROM VARIOUS SOURCES

Claire Frenot (s)
Frivola (s)
General Gallieni (s)
Jean Rostand (s)
Louise Rozain (s)
Sereno (s)

STANDARD VARIETIES

Berthe de Presilly (d)
Colonel Thomas (d)
Edmond Blanc (d)
General Grant (d)
Henriot (d)
Jean Oberle (d)
Jean Viaud (d)
Jean Violette (d)
Leopold Bouille (d)
Mme. Barney (d)
Mme. Landry (d)
Monsieur Emile David (d)
Ornella (d)
S. A. Nutt (d)
Antithese (s)
De Courtillolesde Angleville (s)
Feur (s)
Gloire de Rouge (s)
Gabriel Montoya (s)
Granville (s)
Jacquerie (s)
Mme. Mosnay (s)
Raymond Poincare (s)

SCENTED-LEAVED VARIETIES

(Foliage Only)

Apple
Balm
Capitatum (rose scented)
Dale Park Beauty
Fair Ellen
Lady Mary
Lady Plymouth
Lemon (lemon scented)
Mrs. Kingsbury
Nutmeg
Quercifolium
Rose
Scarlet Unique

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[1] d = double; s = single; s-d = semi-double.

OTHER VARIETIES NOT CLASSIFIED IN THE ABOVE LIST

Bohemos
Convoitise
Double White
Doctor Phillippe Tissie
Elsa
Fiat
Gettysburg
Heteranthe
Leon Riotox
Lya Berger
Missie Schmerber
Pelargonium peltatum
Rosafiera
Smith Seedling
Scevola
Forest Park Beauty
Mme. Chevaliere
Preslly
Andre Allar
Duchess de Chailles

MISSOURI BOTANICAL GARDEN STUDENTS' CLUB

The Missouri Botanical Garden Students' Club announces the following program for the period March 5—May 21. Attention is called to the change in the time of the meetings, the latter now being held on the first and third Fridays of each month instead of on the corresponding Thursdays. As previously announced, all meetings are held in the graduate lecture room, Tower Grove and Botanical Avenues. Entrance to the lecture room is through the main office door. All persons interested are cordially invited to attend the meetings.

Friday, March 5, 8:15 P. M.

C. H. Thompson—Relationship between plants and animals.
F. G. Grossart—History of landscape gardening.

Friday, March 19, 8:15 P. M.

G. H. Pring—Aquatic gardening.
A. J. Cella—Lawns and their care.

Friday, April 2, 8:15 P. M.

C. W. Garrett—Roses for St. Louis.
P. A. Kohl—Value of birds in horticulture.

Friday, April 16, 8:15 P. M.

Dr. B. M. Duggar—Culture of mushrooms.

Friday, May 7, 8:15 P. M.

C. Pedlow—Insects affecting shade trees, and their eradication.
C. F. Giebel—Mimicry.

Friday, May 21, 8:15 P. M.

Dr. H. von Schrenk—Preservation of woods.

NOTES

Miss Herta Toeppen, a graduate of the Garden course, visited the Garden January 2.

Mr. J. F. Groves, graduate student in botany at the University of Chicago, recently visited the Garden.

Professor A. H. Gilbert of the State University, Lexington, Kentucky, consulted the library during the Holiday recess.

Professor Leo E. Melchers, Pathologist at the Kansas Agricultural College, Manhattan, Kansas, visited the Garden January 6.

The fourth number of Volume I of the Annals of the Missouri Botanical Garden has been issued, with the following contents:

"Thelephoraceae of North America III. Craterellus borealis and Cyphella." E. A. Burt.

"Some Oenotheras from Cheshire and Lancashire." R. R. Gates.

"A Texan Species of Megapterium." R. R. Gates.

"Diagnoses of Flowering Plants, Chiefly from the Southwestern United States and Mexico." J. M. Greenman and C. H. Thompson.

"Enzyme Action in Fucus vesiculosus L." B. M. Duggar and A. R. Davis.

Mr. Robert Meyer, a former Garden student, has recently returned from the Philippine Islands, and is at present living at 3818 Arsenal Street, St. Louis.

At the meeting of the Garden Students' Club on February 19, Mr. C. W. Garrett spoke on "Pruning Trees and Shrubs," and Mr. P. A. Pfaender on "The Uses of Dynamite."

On January 14, Mr. G. H. Pring addressed the Garden Club of Webster Groves, Mo., on "Aquatic Gardening." Various types of lilies from the Garden collection were illustrated by photographs.

Mr. John Noyes, Landscape Designer to the Garden, spoke before the Garden Club of Webster Groves, Missouri, February 18, on "How the Improvement of Home Grounds Promotes City Planning."

Mr. W. W. Bonns, Assistant Professor of Pomology at the College of Agriculture, University of California, stationed at the Graduate School of Tropical Agriculture, Riverside, California, has begun work toward his doctorate in the graduate laboratory.

Mr. D. S. Brown of Kirkwood, Mo., has presented the three following interesting Cypripedium hybrids to the Garden: "The Earl," "St. Albans," and "Prospero," the latter having been raised by Mr. Brown from the parents *Cypripedium insigne Sanderae* and *C. Spicerianum*. A specimen of *Aphelandra aurantiaca* was also presented.

STATISTICAL INFORMATION FOR JANUARY, 1915

GARDEN ATTENDANCE:

Total number of visitors	1,498

PLANT ACCESSIONS:

Total number of plants received in exchange	12
Total number of plants donated	40
Total number of seed packets received in exchange	9

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	26
Total number of books and pamphlets donated	40

HERBARIUM ACCESSIONS:

By Purchase —	
R. Friedländer & Sohn—Sydow's "Mycotheca germanica," Fasc. XXV and XXVI, Nos. 1201-1300	100
J. M. Holzinger—Flowering plants of New Mexico	111
By Gift —	
E. Bartholomew—Fungi from the Southern States	25
S. H. Burnham—Specimens of fungi from New York	21
B. F. Bush—Plants of Missouri	286
G. P. Clinton—Specimens of fungi from Connecticut	2
J. A. Drushel—Plants of Illinois, Missouri, and Ohio	6
W. G. Farlow—Fungi, mostly from southeastern United States	57
O. S. Ledman—Fungi of Illinois	2
E. O. Matthews—Plants of Mexico	61
J. N. Rose—*Puya sp.* from Bolivia	1
H. von Schrenk—*Scleroderma Geaster* from Mississippi	1
W. T. Swingle—Photographs of types of *Senecio*	8
E. Teas—*Camellia* (*Thea*) *Sesanqua* Thunb. var. *semiplena* Hort. from cultivated specimens	1
By Exchange —	
A. W. Evans—Hepaticae of Jamaica	35
By Field Work —	
E. J. Palmer—Plants of Missouri	21
TOTAL	738

The Garden is open to the public week days the year 'round from 8:00 A. M. until one-half hour after sunset. Admission free. Beginning with the first Sunday in December and continuing until April 4, the Garden is closed Sundays.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

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P. FOERSTER,
Farm and Stables.

M. SCHILLER,
New Conservatories

K. N. SVETLIKOFF,
Plant Breeding and Seeds.

MISSOURI BOTANICAL GARDEN BULLETIN

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Missouri Botanical Garden Bulletin

Vol. III St. Louis, Mo., March, 1915 No. 3

SPRING IN THE GARDEN

Springtime brings with it more important duties in the garden than any other season of the year; furthermore, it is the season at which many of the things essential to the future success of the garden should be done,—things which either cannot be done at all or are accomplished at a disadvantage later in the season. Too frequently the early spring days pass before it is realized that plants are growing, that seeds are sprouting, and that the proper time for starting a garden has already passed; a garden should be made before, not after, the leaves are on the trees. The spring gardening season being close at hand, the following notes have been prepared embodying certain suggestions for some phases of the season's work.

Lawns.—The lawn undoubtedly should receive the first attention in the spring. After the frost is out of the ground and as soon as the lawn is in such condition that it can be comfortably walked upon, it should be thoroughly raked with an iron rake in order to remove all dead grass and other material, such as stones, sticks, and leaves. Thorough raking further tends to loosen the soil, thereby rendering the latter a good growing place for grass seed, which should be applied after the raking. On established lawns, reseeding is not always necessary, though it is not a bad practice to reseed all lawns lightly whether they seem to need it or not. On established lawns, only blue-grass and red top need be used, whereas the addition of Italian rye and Rhode Island bent is desirable for new lawns. In reseeding established lawns many people prefer to add a little white clover, others, however, choosing only blue-grass or red top. After the seed has been sown, the lawn should be very lightly covered with either good rich soil, prepared humus, or thoroughly decomposed cow or horse manure. The purpose of this application is obviously to cover the seed and to give it a good rich medium in which to grow. Where soil or prepared humus is used, it is desirable to add some fertilizer,

such as sheep manure; but where, on the other hand, the application is one of cow or horse manure and soil, the addition of sheep manure is unnecessary. It is difficult, however, to get cow or horse manure in a sufficiently decomposed state to use as a dressing for lawns in the spring.

After the lawn has been treated as above, it should be rolled with a heavy roller, or if this is not possible it should be well tamped. The winter frosts have tended to loosen the sod and have made the surface very uneven. Raking, dressing and rolling usually suffice to again put it into good condition.

Too much stress cannot be laid upon the importance of completing this spring treatment of the lawn as early as possible—surely before the grass becomes green, for in St. Louis, at least, successful lawns are secured only when the work of preparation is done early. The seed must germinate and the young grass plantlets must become well established early in the season in order that the heavy spring rains may not be able to dislodge them, and, furthermore, that they may be sufficiently advanced in their development to endure the hot dry weather of the early summer. Depending upon conditions, the following amounts indicate in a general way what may be necessary to bring a lawn into proper condition: grass seed, 25-50 pounds per acre; humus, manure, or soil, 3-10 tons per acre; sheep manure, 200 pounds per acre.

Trees and Shrubbery.—All pruning of trees and shrubbery should certainly be done before the starting of the buds in the spring. Trees should be pruned of all dead limbs and water sprouts, or suckers. Dead limbs are readily distinguished from living ones by the absence in the former of a green layer directly underneath the outermost layer of bark, a condition which, at least in young shoots, can readily be ascertained by the use of the thumb nail. Water sprouts, or suckers, are the small shoots almost invariably produced on the larger limbs of trees and frequently also on the trunk near the point at which the latter emerges from the soil. All of these should be removed. Aside from these general suggestions, it is almost impossible to give directions which will enable one unfamiliar with the general subject of pruning to properly prune a tree. Where trees have been properly cared for in the past, however, it is very seldom necessary to remove limbs over two and one-half to three inches in diameter; more severe pruning should never be attempted by an amateur. It is true that it has frequently been done in St. Louis by men who claimed to be experts, but the hideous

results of their work are apparent in many private places all over the city. If there is any doubt in regard to the pruning of large trees, it is desirable to call in a known expert for advice.

Shrubs, while just as amenable to good and proper care, suffer less from neglect than do trees. A general rule applicable to the pruning of shrubs is that early-flowering shrubs are preferably pruned after blooming, and late-flowering ones in winter or early spring. Early-blooming shrubs usually produce their flowers on wood developed the previous season, while the later-flowering ones produce them on new wood. The golden bell, or Forsythia, for instance, blooms in the very early spring on the woody growth made the previous summer. If this were pruned away in the spring all the "flower wood" would be destroyed. On the other hand, hydrangeas bloom late in the season on the ends of shoots produced that year from buds on the old wood. It is usually customary to prune hydrangeas (in the spring) back to two or three buds, as the flower crop is thereby not endangered. If good results are to be obtained from the pruning of shrubs, therefore, the time and habit of their blooming must be carefully taken into account.

Trees and shrubs are often affected with scale insects and other diseases. During the summer months it is almost impossible to kill the former without injuring the foliage; in winter or early spring, therefore, also this important work must be done. It is safe to say that in St. Louis no large group of woody plants is entirely free from destructive scale insects, and it is recommended that at least once each winter or early spring a competent gardener be called upon to thoroughly spray the trees and shrubs. If spraying is to be done on an extensive scale, a spray pump is necessary, but if only a few plants are to be treated, a pail and whisk broom will suffice. Trees and shrubs may be sprayed in the early spring by using the well-known Bordeaux mixture, made as follows:

A. Dissolve four pounds of copper sulphate in four gallons of water.

B. Dissolve four pounds of quick lime in four gallons of water.

Place solution A in a barrel or spray tank having a capacity of fifty gallons and add thirty-eight gallons of water. Dilute solution B in four gallons of water and after thorough stirring add to the solution in the barrel. When mixed the solution is ready to apply.

Solutions A and B may be made up in greater quantities, using the same proportions, and kept as stock solutions.

If disease appears after the foliage is on the trees, the same mixture may be used, but, except for fruit trees, one

early spraying should be sufficient for a season. If caterpillars appear after the leaves have come out, it will be necessary to spray again with a poison, such as Paris green or arsenate of lead.

In the care of woody plants it is further important that the soil beneath the trees and shrubbery be dressed with manure, and the latter spaded in. This is not always possible in the case of trees on the lawn, but all shrubbery borders should be so treated in the spring, and furthermore the soil of these should be kept well tilled, or cultivated, throughout the summer.

Perennials.—Such plants as phlox, golden glow, golden rod, and asters, which grow from roots, bulbs, or root-stocks that remain dormant in the soil during the winter, are known as perennials. There exists considerable disagreement as to the best time for moving and rearranging plants of this class, i. e., whether it should be done in the fall or spring. However, if the work is not delayed too long in the spring, there is not much choice, and shifts may be made at either season. Perennials, when healthy, become crowded and overgrown, and when this condition arises they should be dug and divided into smaller clumps. The soil should be spaded deeply, enriched with manure, and the plants reset, allowing sufficient space between individuals to obviate the necessity of again shifting them within the next two or three years. Perennials, as a rule, unless very carefully handled, are likely to bloom less profusely the first season after shifting, but in subsequent years the increased flower production will usually more than compensate for the loss sustained during the first season. All old growth of perennials should be removed before the new spring growth begins, and if the plants have been covered with a mulch of straw or manure during the winter this should be removed and the ground between the plants thoroughly spaded.

Annuals.—Seed beds for annuals to be planted in the spring should be spaded and enriched by the addition of manure. Whether geraniums or some delicate annual plants are to be used, the soil should be in good tilth before planting. In this connection, it should be noted that the florist is accustomed to speak of all bedding plants as annuals, because they are used as such. Cannas and geraniums are of perennial habit, yet they are treated as annuals; and this is true of a great many of the tropical plants used for bedding purposes.

Much time may be saved by ordering seeds early, and if these are started in the house in wooden boxes or flower

pots the plants will be of good size when planting time arrives. House-grown plants are usually better able to establish themselves out of doors in the spring than are the plants grown from seed sown directly in the ground out of doors. If a box about two feet square and three to four inches deep is first filled with about an inch of gravel or coarse stone, and this covered with soil, an ideal place in which to start annuals will be provided. The surface of the soil should be made firm by pressing it with a flat piece of board. On this surface the seed is sown—not too thickly—and then covered with sand or some very light soil. When the seed has germinated, the small plants should be transplanted into another box, sufficient distance being allowed between them for the healthy development of the seedlings. St. Louis soil contains so much clay that when seeds are sown in the open it is difficult for the very young plantlets to penetrate the crust made by the action of rain and sun. For this reason many failures are experienced with annuals, the majority of which may be prevented by growing the seedlings indoors in seed flats.

CELERY GROWING IN ST. LOUIS

Celery is a garden product good only while perfectly fresh. Its flavor and crispness are soon lost after the plants are removed from the conditions surrounding their growth. For the last few years celery has been grown at the Garden which, because of its flavor and tenderness, has caused considerable comment. Since it is possible to grow good celery on a small scale and with but little effort, it has seemed well to devote a little space in the BULLETIN to a discussion of its culture.

In selecting celery seed it must be remembered that there are both early and late varieties. The varieties known as White Plume, Golden Self Blanching, and Golden Heart may be classed as early, while such varieties as White Queen and Giant Pascal should be selected for winter use. All of these are recommended for trial in St. Louis.

Seed should usually be sown about the last of March or during the first two weeks of April. They may be started in a cold frame, or sown in the same drills with radishes or onions in the open ground. About the time the celery plants need more room, the early crop of radishes or onions can be removed, thus saving space in the garden and causing the same ground to serve a double purpose. Seed should be thinly scattered in the drills, or on the seed bed, if in a cold

frame. Celery seed is so small that it hardly needs covering with soil and it is frequently better to merely press the seed into the soil with a flat piece of board. The seed bed should be thoroughly watered and kept moist throughout the growth of the plants. If the seed has not been sown too thickly, the plants may be left in the rows, or seed bed, until they are five to six inches in height. Any good light garden soil is sufficient for this first growth, but when the plants are moved into the place where they are to be matured some preparation will be necessary. Celery plants like best a low-lying, moisture-retaining, but well-drained soil of a sandy nature, containing large quantities of decomposed organic matter. In growing celery it is best to use a part of the garden that in previous years has been heavily fertilized with manure and grown to other crops. Such a soil is likely to be in good tilth and in a fair condition for celery. The application of fresh barnyard manure should be avoided, as it not only spoils the flavor but also impairs the appearance of the plants by causing a rusty spotting of the stalks. The young plants should be reset in good rich soil in rows, the latter at least four feet apart, the plants being placed about eight or ten inches apart in the row. Some labor may be saved in the later operation of banking if the plants are placed in rows that have been depressed several inches. Some time in August the plants will have grown sufficiently to admit of banking with soil in order to bleach the stalks. The latter will have spread apart and may need temporary tying until the soil has been banked against them. The plants will continue to grow taller, and additional banking will be necessary as they grow. Where there are only a few plants, the bleaching of the stalks may be effected by placing a short length of drain tile over each plant so as to keep the light from the stems, or the stems may be wrapped with heavy paper, or boards may be placed lengthwise of the rows against the stalks and kept in place by means of stakes. The main object is to keep the light from the stalks. However, it is a generally accepted fact that the flavor of the plants is much improved by contact with the soil during bleaching. Plants banked with soil may be left out of doors during the winter months if the additional protection of a manure mulch is provided. As the stalks are wanted for use they can be dug by simply removing the manure; the soil beneath the manure mulch should never be allowed to freeze. Care should be taken that water does not stand in or near the soil banking the celery, as this would undoubtedly cause the stalks to rot. After bleaching, celery may be stored in a cool cellar by placing it in soil or sand. Such plants will

need to be kept fresh by watering, but should never be soaked or placed where the temperature is more than a few degrees above freezing.

EXHIBITION OF GARDENING BOOKS

Beginning with the 29th of March, there will be on exhibition in the Museum (No. 15 on map of Garden distributed at main gate) a general collection of books of interest to those who have anything to do with flower gardens of any kind. In addition to books treating the home garden as an entirety and various aspects of landscape work, there are special volumes on roses, iris, sweet peas, lilies, etc. There will also be found a considerable number of books on trees and hardy shrubs, vegetables and mushrooms, as well as some of the more useful gardening and horticultural magazines. In the same room is shown a unique collection of specimens illustrating the diseases of living trees and timbers, due to fungous growths or insects. The exhibition will be open every week-day afternoon, from two until five o'clock.

OPEN SUNDAY SEASON

Beginning with Easter Sunday, April 4, and continuing until the last Sunday in November, the Garden will be open every Sunday afternoon from two o'clock until sundown. In the floral display house on the first open Sunday there will be a collection of about one thousand cinerarias, with roses, lilies, and various other flowering and foliage plants in profusion.

NOTES

Dr. Barker, of the Department of Plant Breeding of Cornell University, visited the Garden on March 3.

Twenty-five members of the St. Louis Section of the American Nature-Study Society visited the Garden on March 5.

The botany class from Forest Park University, St. Louis, in charge of Miss McClure, visited the Garden February 18.

On March 18, Mr. C. Garrett addressed the Webster Groves Garden Club, of Webster Groves, Missouri, on the subject of "Roses."

The March number of "The American City" contains an article on "The 'Places' of St. Louis," by Mr. John Noyes, Landscape Designer to the Garden.

The collection of Indian jasmines (*Ixora undulata*) are in full flower in the epiphytic orchid house. They are extremely showy plants, native of India.

On March 16, Mr. F. S. Grossart spoke before the Entomological Section of the St. Louis Academy of Science on "The Evolution of the Chrysanthemum."

On March 11, Mr. W. W. Ohlweiler, General Manager to the Garden, spoke before the St. Louis Florists' Club at the Odd Fellows' Building on "A Few Things About Soils."

In the last two months the Garden class in engineering has visited greenhouse ranges at Kirkwood and Crescent, Missouri, and at Edwardsville, Illinois. These inspection trips constitute a part of that phase of the engineering course which relates to greenhouse construction.

In the banana dome adjoining the orchid house a specimen of the red banana and one of the commercial yellow banana are at present in fruit. In addition, two yellow banana plants are just coming into flower. Attention is called to the article on the banana which appeared in the September, 1914, number of the BULLETIN, in which will be found a more or less detailed discussion of the flowers, fruit, cultivation, and commercial uses of this important food-yielding plant.

The following is a list of new members of the Missouri Botanical Garden Alumni Association who have joined since January, 1915:

Active

Otto Bogula, 394 Military Avenue, Detroit, Michigan.
Edwin Nyden, 303 Court House, Portland, Oregon.
Walter Retzer, Main and Rusk Streets, Houston, Texas.
Miss Herta A. Toeppen, 20th Century Club, 595 Delaware Avenue, Buffalo, New York.

Associate

Clark W. Craig, Rush Lake, Wisconsin.

On the evening of March 18, the Washington University Chapter of the Society of the Sigma Xi was the guest of the Garden at a meeting and smoker in the graduate lecture room and laboratory. The formal part of the program consisted of an address by Dr. George T. Moore, Director of the Garden, on "Botany as an Applied Science," and a discussion by Dr. B. M. Duggar, Physiologist to the Garden, in charge of Graduate Laboratory, of the general aspects of the botanical research work carried on in the graduate labora-

tory of the Garden and a brief digest of some of the individual investigations recently completed or in progress. Opportunity was given the members to inspect a series of laboratory demonstrations illustrating the problems and methods involved in some of the investigational work in progress by members of the staff and graduate students of the Garden. About fifty members of the society were present.

STATISTICAL INFORMATION FOR FEBRUARY, 1915

GARDEN ATTENDANCE:

Total number of visitors	2,865

PLANT ACCESSIONS:

Total number of plants received in exchange	144
Total number of seed packets received in exchange	12

LIBRARY ACCESSIONS:

Total number of books bought	19
Total number of books and pamphlets donated	88

HERBARIUM ACCESSIONS:

By Purchase —

E. Bartholomew—"North American Uredinales" Cent. XII, XIII, Nos. 1101-1300	200
B. F. Bush—Plants of Missouri	230

By Gift —

I. W. Bailey—"Vegetable sheep" or "Yareta" from Peru	1
O. C. Charlton—*Carya glabra* var. *villosa* from Texas	1
J. Dearness—Fungi from Vancouver, British Columbia	24
J. Dearness—Fungi from Ontario, Canada	18
J. A. Drushel—Plants of Alabama and Ohio	6
F. Gravatt—Specimens of fungi from Virginia	2
J. H. Kellogg—Plants of Missouri	242
E. O. Matthews—Specimens of fungi from Mexico	4
C. R. Orton—Specimens of *Stereum* chiefly	19
C. E. Owens—*Stereum purpureum*	1
L. Romell—Specimens of fungi	2
H. von Schrenk—*Pinus echinata* Mill. and *P. Taeda* L. from Texas	5
W. A. Setchell—*Leptobasidium* associated with scale insects	1
F. A. Wolf—*Corticium caeruleum*	1

By Exchange —

Bureau of Science, Manila, P. I.—Plants of the Philippine Islands	700
W. G. Farlow—Mosses from Trinidad and Granada, W. I.	19
New York Botanical Garden—*Agalinis acuta* Pennell from New York	1
University of California—Photograph of *Calycadenia Fremontii*	1
U. S. National Museum—Fragments of types of *Senecio* in the U. S. Nat. Herbarium	15
Specimens of *Senecio* from the Carnegie Institution—N. Y. Bot. Garden Explorations in South America	20

U. S. Dept. of Agriculture, Bureau of Plant Industry—Plants of China, collected by Mr. F. N. Meyer.....	98
TOTAL.....	1,611

The Garden is open to the public week days the year 'round from 8:00 A. M. until one-half hour after sunset. Beginning with Easter Sunday and continuing until November 30, the Garden will be open Sundays from 2:00 P. M. until sunset. Admission free.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

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OF THE MISSOURI BOTANICAL GARDEN

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Assistant to the Director,

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Landscape Designer.

E. D. EMME,
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J. ERDMAN,
Plant Propagation.

C. R. FOLLEN,
Construction.

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Farm and Stables.

C. W. GARRETT,
Outside Floral Displays.

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Carpentering Department.

W. F. LANGAN,
Engineer.

G. H. PRING,
Orchids and other Exotics.

M. SCHILLER,
New Conservatories.

K. N. SVETLIKOFF,
Plant Breeding and Seeds.

MISSOURI BOTANICAL GARDEN BULLETIN

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TWO MOUNDS OF YARETA GROWING ON MT. CHACHANI, NEAR AREQUIPA, PERU.

Missouri Botanical Garden Bulletin

Vol. III St. Louis, Mo., April, 1915 No. 4

THE YARETA OR VEGETABLE SHEEP OF PERU

Professor Irving W. Bailey, who for several years resided at Arequipa, Peru, recently sent to the Garden for identification a dried specimen of a very curious plant which is known by the native Peruvians as "Yareta" or "vegetable sheep." The plant grows abundantly among rocks at high altitudes along the Andes of Bolivia and Peru, where it constitutes a conspicuous feature in the landscape because of its peculiar manner of growth in developing the so-called "polster" or cushion formation.

Similar compact masses of plant growth are frequently found on high mountains, as well as in arctic and antarctic regions. Such, for example, are the relatively small clumps or cushions of *Diapensia lapponica* L. on the alpine summits of New England and in northern Europe, also several of the saxifrages in the Rocky Mountains, and the well-known "vegetable sheep" (*Raoulia mammillaris* Hook.) of New Zealand; but nowhere in the world are known to occur such huge masses as are developed by the Yareta (*Azorella sp.*) of the Andes and by other members of this genus in the Falkland Islands.

The size and general appearance of this peculiar plant are shown in Plate 1, made from a photograph taken by Professor Bailey on Mt. Chachani, near Arequipa, at an elevation of fully 17,000 feet above sea-level. It forms hillocks or small mounds often becoming three feet high and sometimes several feet in diameter. Moreover, the entire mound is made up of a single plant, not of a colony of individuals, and it attains this enormous size and extreme compactness by a process of repeated branching (Plate 2), so that the ultimate branches are closely crowded and the outer surface is continuous (Plate 2). The flowers of the Yareta are very tiny, only about two millimeters, or less than one-eighth of an inch, long, and are borne in small sessile, axillary, involucrate clusters near the tips of the branches; and the fruit is somewhat like a miniature caraway seed.

Like other members of the Umbelliferae—the natural family to which the plant belongs—the younger branches are rich in oil-secreting cells and oil tubes, so that the whole structure becomes completely infiltrated with a resinous content. The dried specimen at hand has much the odor of old honeycomb or beeswax. Living specimens are said to have such a powerful odor that their presence can be detected even at some distance from the plant itself. The presence of such a large amount of resinous content and its exudation over the surface renders the Yareta of very considerable economic value, since it is gathered in quantity, taken to Arequipa and there used extensively for fire-wood. One correspondent writes that it is "brought down to Arequipa by the car load and forms the principal fuel of that town."

CALCEOLARIAS AND GLOXINIAS

The exhibition of a large variety of calceolarias and gloxinias in the Floral Display House during this month and the early part of May warrants some discussion of these plants at this time.

Calceolarias.—The common name for the numerous species and varieties of the genus Calceolaria is "slipper plant" or "slipper wort," derived from its Latin name. However, as these terms are much better and more generally applied to the orchid Cypripedium, there seems no good reason for increasing the confusion by applying to the calceolarias any other than their real name.

The plants shown at the Garden and usually grown by florists are of the herbaceous type. These are practically all hybrids derived from wild species, obtained originally from South America. There is also a shrubby variety, used in England and on the Continent as a bedding plant, but this cannot be grown successfully in this latitude because of the heat. Few greenhouse plants have been more improved during recent years than the herbaceous calceolarias, both with respect to the constitution of the plant and the beauty of the flowers. The requirements of these plants are simple, and anyone possessing a growing place from which frost can be excluded without them being subjected to the abnormal drought of the average home, can cultivate them with success.

Seeds of the herbaceous calceolarias may be sown in May, June or July, but plants raised from June sowings generally give the best results. Equal parts of loam and leaf mold, to which has been added a little sand, make a suitable soil, and this should be well watered before planting the seed.

FRAGMENT OF VARETA. ABOUT NATURAL SIZE.

These are very small and must be handled carefully. They should be sown thinly in pots, covered very lightly with soil, and, if no cold frame is available, each pot covered with a piece of glass which should be turned over daily to prevent the condensed moisture dropping down on the seed. The glass will keep the soil moist and also hasten germination. It should be removed altogether after the seedlings have broken through the soil. Sometimes it is a good plan to place the pots containing the seed on inverted flower pots standing in saucers of water. This will keep the surroundings moist and likewise prevent certain crawling insects from feeding upon the young seedlings. The plants should be transplanted as soon as they produce a second leaf, for if left too long in the seed pan they fail to make good plants. Soil similar to that in which the seed germinated should be used for the potting, since calceolarias need a rich porous medium in which to develop. Care should be taken to select the weaker as well as the stronger seedlings, for the best colors are often found in the seedlings developed last; it is a general belief among growers that the stronger seedlings produce the greatest percentage of plants with yellow flowers, or flowers in which yellow predominates. The young seedlings should not be exposed to the direct rays of the sun and the roots should not be allowed to become dry.

When the young plants have four or five leaves, they should be repotted and allowed to develop until September, at as low a temperature as possible and under conditions of good ventilation. By this time the calceolaria plants are ready to be transferred to larger pots in which they may remain over winter. High temperatures should be avoided, from 45 to 50°F. being ample. As soon as growth begins in the spring the plants are ready for their final shift into six or eight-inch pots. Pot firmly but do not pack the soil so that it will prevent free ramification of the roots. When the pots are filled with roots, manure water may be added occasionally, but as soon as the flowers appear, clear water only should be given. Herbaceous calceolaris grown in this way and kept in a cool moist atmosphere with an abundance of light and air will produce an abundance of flowers in March or April.

Gloxinias.—The genus Gloxinia was founded in 1785 upon a plant obtained from Brazil and named in honor of P. B. Gloxin, a botanist of Strassburg. In 1817 another plant from Brazil, closely related, was named *Gloxinia speciosa* and it was from this species that our present horticultural varieties of gloxinia originated. Later it was found that this parent of our garden gloxinias was not a true

Gloxinia, botanically speaking, but belonged to another genus in the same family, namely, Sinningia. The name gloxinia had become too well fixed among growers to be changed, however, and consequently there exists the peculiar condition of a plant bearing what is supposed to be its botanical name, but which in reality is only a common name derived from a botanical name, erroneously applied. In all probability these plants will continue to be known as gloxinias, but if one wishes to refer to them under the genus to which they belong, the name Sinningia should be used.

During the last ten years gloxinias have been wonderfully developed by various growers. Flowers now range from pure white, pink, and pale blue to deep red and purple. The newer French, spotted hybrids, though less robust in habit and with more delicate flowers, are a valuable addition to the older types. These are marked and spotted with colors varying from pink and mauve to dark blue, red, and even chocolate.

The cultivation of gloxinias is not so simple as that of calceolarias, but anyone with a warm greenhouse or even a hot bed at their disposal, by selecting good seed and following the hints given below should be able to produce a brilliant display of blooms within seven or eight months after sowing the seed. It is best to sow the seed in mid-winter in deep, well-drained pans filled with a mixture of rich soil and sand. The pans should be kept at a temperature of about 75°F., and may be covered with glass until the seedlings appear. Great care should be taken to turn the glass night and morning as gloxinias are especially liable to "damp off" in too moist an atmosphere. As soon as the first leaves develop, the plants should be pricked off into shallow pans or pots, and when the seedlings are established they may be removed from the hot bed into a fairly moist atmosphere at 65–70°F. When large enough to handle easily, the seedlings must again be transplanted into a soil as fibrous and porous as possible, peat, sand and leaf mold making a good combination. Careful watering is most important at this stage. If possible, the water should be slightly warmer than the air of the house and moreover should never be applied unless really necessary. The atmosphere, however, should always be moist, and the leaves may be lightly sprayed night and morning.

In the final potting—this time into six or eight-inch pots—a good mixture of equal parts of peat, leaf mold, clay, and sand should be used, and the soil ought not to be colder than the house atmosphere. The plants should be kept at a temperature of from 65 to 70°F., never less than 60°,

and given all the light possible without exposure to the direct rays of the sun.

Further feeding is not necessary during the first season. Plants started in January or February should bloom in July or August. When the flowers appear, a little weak manure water may be of benefit but its use can easily be carried too far. It is sometimes advisable during the blooming period to remove some of the center leaves which may otherwise cramp and smother the opening flowers.

After flowering, water should be gradually withheld and as soon as the leaves have ripened, the plants should be stored at a temperature of about 45°F. Only enough water should be given to prevent the tubers from withering. In February the tubers should be cleaned and placed in small pots filled with the soil mixture referred to above. Until active root growth begins but little water should be given, and as soon as the pots are filled with roots, it is necessary to transfer the plants into six-inch pots. Plants from last year's tubers should bloom in about five months, and the same tuber may be grown for several years.

To sum up: gloxinias require plenty of heat and moisture, protection from direct sunshine, a rich, open, light soil, and above all, unremitting and intelligent attention to watering and ventilation. To one who can give all these, the joy of growing them from seed to flower will be ample compensation for the time and labor expended.

TWO NEW GARDENS

Two new gardens, both of formal design, are nearing completion, one to be known as the "Linnean House Garden" and the other as the "Formal Garden." It is expected that they will prove not only beautiful, but instructive, presenting certain important principles of landscape design and containing most of the plants that can best be used in gardens of the kind in this locality. Plans of these two gardens are shown on pages 53 and 56.

The Linnean House Garden is situated at the northern extremity of the main garden, and derives its name from the Linnean House, which is its central and main feature. The garden is bounded on the north by a high brick wall and the Linnean House, on the east and west by high stone walls, and on the south by a hedge with an informal border plantation. The enclosure is about 413 feet long on the east and west axis and about 84 feet wide on the cross axis on either side of the Linnean House.

The garden was designed to conform with, and utilize to the best advantage, the main features already existing, of which the Linnean House and the high walls are the most interesting and noteworthy. The general effect will be similar to that of the so-called "English" type of formal gardens, particularly those enclosed by a wall. The garden really comprises three smaller gardens, the west one, the "Perennial Garden," the east one, the "Annual Garden," and the middle one, "The Pools," the latter directly south of the Linnean House. In detailed design these smaller gardens all differ materially from one another. The final intention is to devote the Perennial Garden entirely to perennials and the Annual Garden exclusively to plants of annual habit, and it is hoped that these gardens may ultimately contain a large proportion of the plants of their respective classes which will endure the local climatic conditions. Certain unusual plants, requiring special conditions such as rock garden, subtropical, etc., plants will be omitted. For the present, however, perennials will dominate both the Perennial and the Annual Gardens. The rigid formal lines of the walks, the walls, and building will be very much softened by the informality of these various groups of plants.

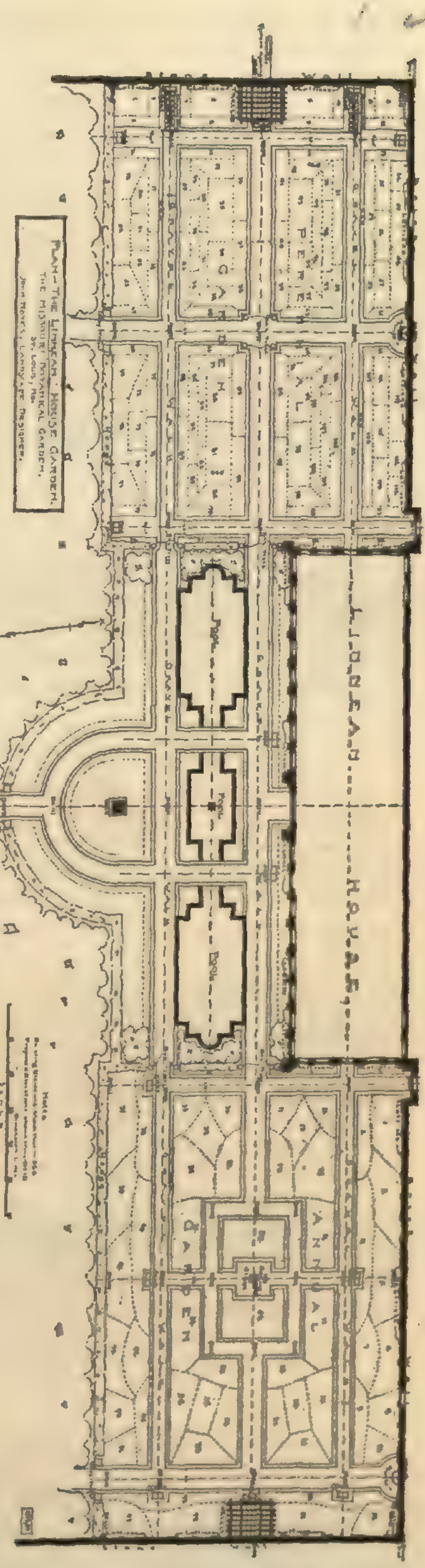
The middle garden will be occupied principally by brick-walled pools with limestone coping, devoted to tropical water-plants, principally Victoria and Euralia. The pools will be equipped with steam pipes for heating the water during cool weather. Tropical, sub-tropical, and flowering plants of brilliant hues will occupy the beds around the pools. The middle garden will therefore present an effect totally different from that of the gardens on either side.

The main east and west walk leads to two trellised summer-houses. Various vines will hide their framework, making the benches inside a cool and inviting retreat in summer. Where the main cross walks reach the wall lion-head fountains, arched over with vines, empty into a basin below. Seats and flower boxes are placed along the minor walks, and a gazing globe will be an interesting feature of the Annual Garden. Vines of wisteria, clematis, akebia, tecoma, etc., covering the trellised summer-houses, latticed walls, and Linnean House will make this spot picturesque and attractive. The following plants, numbered to correspond to their position on the plan, have been planted for this first season in the Perennial and Annual Gardens.

ANNUAL GARDEN

Bed No.

1. *Salvia azurea grandiflora*
2. *Pyrethrum* "Sir James Miller"
3. *Coreopsis verticillata*
4. *Veronica repens*
5. Heliopsis
6. *Chrysanthemum* "Prince of Wales"
7. *Rehmannia angulata*
8. *Lythrum roseum superbum*
9. *Lysimachia clethroides*
10. *Hemerocallis flava*
11. *Chrysanthemum maximum*
12. *Romneya Coulteri*
13. *Lobelia Tupa*
14. *Doronicum magnificum*
15. *Asclepias tuberosa*
16. *Gypsophila paniculata*
17. *Glaucium luteum*
18. *Euphorbia corollata*
19. *Liatris scariosa squarrulosa*
20. *Hibiscus coccineus*
21. *Hesperis matronalis*
22. *Oenothera Youngii*
23. *Oenothera Youngii*
24. *Liatris scariosa squarrulosa*
25. *Hibiscus coccineus*
26. *Hesperis matronalis*
27. *Euphorbia corollata*
28. *Glaucium luteum*
29. *Delphinium formosum*
30. *Delphinium formosum*
31. *Gypsophila paniculata*
32. *Chrysocoma Linosyris*
33. *Doronicum magnificum*
34. *Lobelia Tupa*
35. *Romneya Coulteri*
36. *Chrysanthemum maximum*
37. *Salvia azurea grandiflora*
38. *Pyrethrum* "Sir James Miller"
39. *Coreopsis verticillata*
40. *Veronica repens*
41. *Aconitum Lycoctonum pyrenaicum*
42. *Pentstemon grandiflora*
43. *Chrysanthemum* "Prince of Wales"
44. *Lythrum roseum superbum*
45. *Lysimachia clethroides*
46. *Hemerocallis flava*
47. *Thermopsis caroliniana*
48. *Althaea rosea* (double red)
49 and 50. *Iberis gibraltarica*
51. *Althaea rosea* (double red)
52. *Thermopsis caroliniana*


PLAN - THE LINNEAN HOUSE GARDEN.
THE MISSOURI BOTANICAL GARDEN.
ST. LOUIS, MO.
JOHN ROGERS LANDSCAPE DESIGNER.
TOWER GROVE AVE

PERENNIAL GARDEN

Bed No.

1. *Rudbeckia nitida* "Autumn Sun"
2 and 3. *Helenium superbum rubrum*
4. *Helianthus mollis grandiflorus*
5. *Dianthus plumarius*
6 and 7. *Linum perenne*
8. *Dianthus plumarius* "Cyclops"
9. *Dianthus plumarius delicata*
10 and 11. *Linum perenne*
12 and 13. *Dianthus plumarius* Snow
14. *Dianthus plumarius delicata*
15. *Dianthus plumarius* "Cyclops"
16. *Dianthus plumarius* "Fuerst Bismarck"
17. *Achillea Ptarmica* "The Pearl"
18. *Aster alpinus* "Goliath"
19. *Lupinus polyphyllus albus*
20. *Salvia farinaceae*
21. *Aquilegia vulgaris*
22. *Eupatorium ageratoides*
23. *Baptisia tinctoria*
24. *Echinacea helianthus*
25. *Achillea Ptarmica* "The Pearl"
26. *Aster alpinus* "Goliath"
27. *Pentstemon digitalis*
28. *Chrysanthemum* "Tennyson"
29. *Paeonia Sinensis* "Andre Laurius"
30. *Papaver orientale* "Brightness"
31. *Iris germanica* "Garrick"
32. *Helenium Hoopesii*
33. *Helium superbum*
34. *Aster tataricus*
35. *Cassia Marylandica*
36. *Iris germanica* "Fantasy"
37. *Iris germanica florentina alba*
38 and 39. *Iris germanica* "Mad. de Banne"
40. *Iris germanica florentina alba*
41. *Iris germanica* "Fantasy"
42. *Pentstemon barbatus Torreyi*
43. *Cassia Marylandica*
44. *Boltonia asteroides*
45. *Helenium superbum rubrum*
46. *Papaver orientale* "Mrs. Marsh"
47. *Veronica longifolia subsessilis*
48. *Physostegia virginica*
49. *Aster* "White Queen"
51. *Phlox amoena*
52 to 54. *Phlox divaricata canadensis*

Bed No.

55. *Iris germanica* "Black Prince"
56. *Achillea Millefolium roseum*
57. *Hemerocallis* "Orange Man"
58. *Liatris scariosa squarrulosa*
59. *Centaurea macrocephala*
60. *Aster polyphyllus*
61 to 68. *Iris pumila*
69. *Baptisia tinctoria*
70. *Echinacea helianthus*
71. *Delphinium formosum*
72. *Eupatorium ageratoides*
73. *Papaver indicaule* "Orange"
74. *Monarda fistulosa alba*
75. *Lychnis Viscaria splendens*
76. *Lychnis Haageana*
77 and 78. *Euphorbia polychroma*
79. *Helenium superbum rubrum*
80. *Aster tataricus*
81. *Hibiscus coccineus*
82. *Papaver orientale Parkmanni*
83. *Paeonia Solfatare*
84. *Iris germanica candida*
85. *Asclepias tuberosa*
86. *Coreopsis lanceolata*
87. *Aster* "Madonna"
88. *Lychnis Viscaria splendens*
89. *Lychnis Haageana*
90 and 91. *Euphorbia polychroma*
92. *Iris germanica* "Chamaeleon"
93 and 94. *Iris germanica* "Charlotte Patty"
95. *Iris germanica* "Chamaeleon"
96. *Helenium superbum*
97. *Boltonia asteroides*
98. *Hibiscus coccineus*
99. *Spiraea aruncus*
100. *Paeonia festiva maxima*
101. *Paeonia Delachei*
102. *Echinops Ritro*
103. *Gerbera Jamesoni*
104. *Doronicum plantagineum excelsum*
105. *Phlox subulata Nelsoni*
106 and 107. *Phlox divaricata canadensis*
108. *Phlox subulata Nelsoni*
109. No bed
110 to 113. *Euphorbia polychroma*
114. *Baptisia australis*
115. *Achillea eupatorium*
116. *Hemerocallis* "Orange Man"
117. *Liatris scariosa squarrulosa*
118. *Althaea rosea*
119. *Helianthus mollis grandiflora*

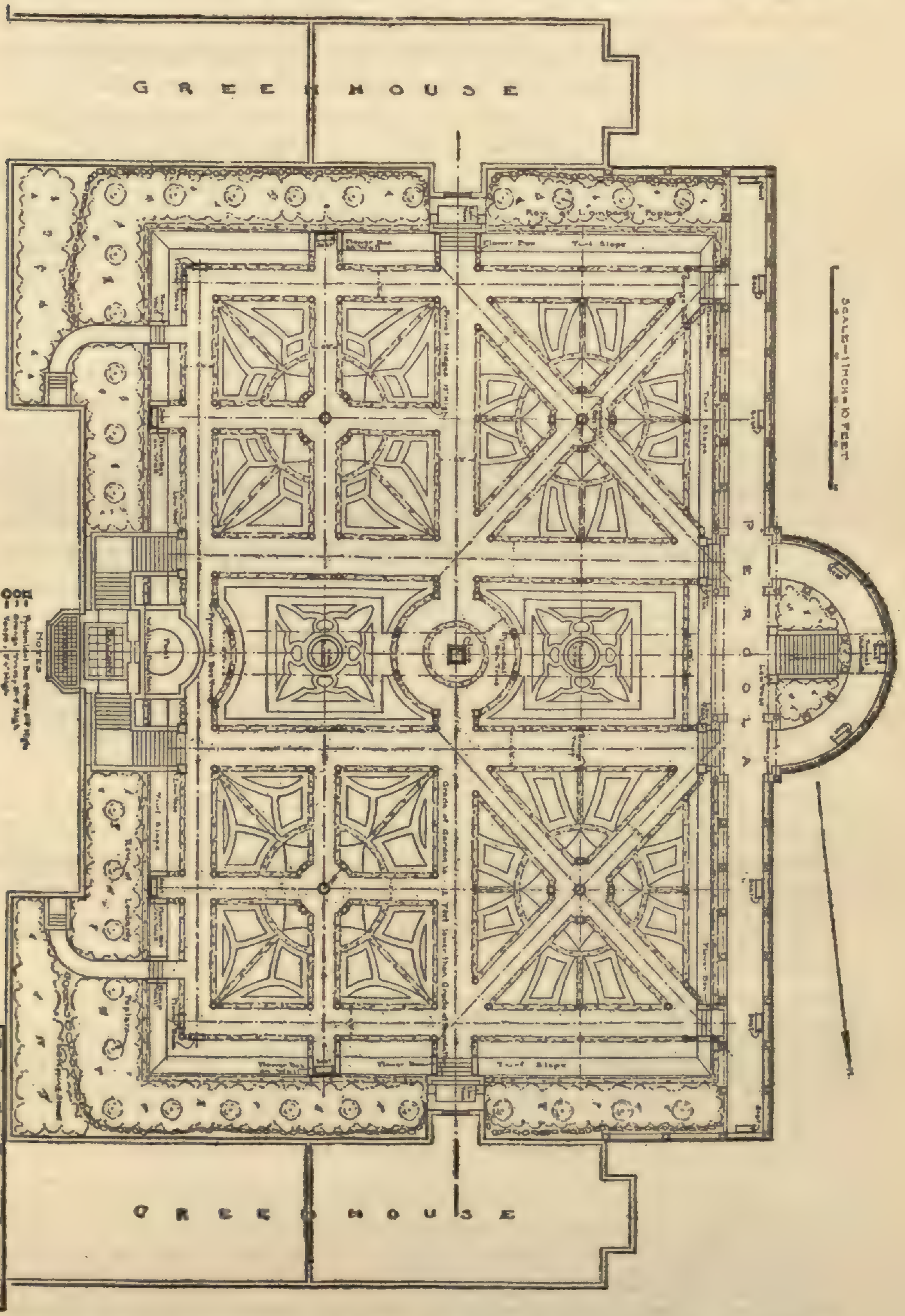
The Formal Garden, with an area of about 35,000 square feet, is located in the court of the new conservatory. It is bounded on three sides—north, south, and east—by sections of the conservatory, and on the west the enclosure has been completed by a pergola. The strictly formal surroundings make a purely architectural design permissable and desirable here. The result is probably the most elaborate and finished garden ever attempted at the Missouri Botanical Garden and if the Linnean House Garden can be called "English," this one might be termed "Italian," since it depends largely upon exact symmetry, preciseness of line and trimness for effect. The color and width of the walks, for instance, are nearly as important to the design as the planting beds themselves and every feature has a significance in the plan. The walks are edged with yellow brick, the same shade as the path itself; low hedges border the walks and govern the design of the beds; numerous vases, flower boxes, and garden seats have been used to set off the terminations of the walks; and the statue of Juno, which formerly was such a familiar object in the main garden occupies the center of the garden and forms its most conspicuous feature. Ultimately there will be two small fountains in the central panels while orange trees and pyramidal box-trees will also be used in the decoration.

The principal feature of this garden during the flowering season will probably be the pattern bedding. It is believed that this form of gardening—usually much abused—is in harmony with the surroundings here. The beds will be most effective from the balcony at the east, which is about eleven feet above the grade of the garden, and also accessible from the palm house.

The main bulb display in spring will be presented in this garden and a succession of bedding and foliage plants will keep these beds a mass of color in summer. The plants to be used in the vases and flower boxes are those best adapted for window boxes. Hence it is hoped that the Formal Garden may show, first the best bedding plants to be used at various seasons, and second a collection of plants most suitable for window boxes, flower boxes, and vases.

A heavy border plantation of hardy shrubs, interspersed with Lombardy poplars surrounds the Garden on the three greenhouse sides, and the pergola at the west will be planted with vines. This pergola will undoubtedly prove a very popular retreat, for from it can be viewed not only the Formal Garden, but also the landscapes which ultimately will be developed to the west.

This garden is equipped with an automatic sprinkling system which, if as successful as is expected, will be installed



in all of the intensely developed gardens. Another item of interest to landscape architects is the unusual feature of a

perfectly level grade, except for the slight crown in the walks.

A garden, whether natural, formal, or Japanese, is never truly finished. If proper maintenance is given and the true intent of the design followed, time will greatly add to its charm, so that each succeeding year should bring these two new gardens nearer to the ideals of perfection and beauty which they are ultimately intended to exemplify.

NOTES

Professor H. M. Kelley of Cornell College, Iowa, visited the Garden on April 10.

Classes from the Cote Brilliante School visited the Garden on March 24, 25, 30, and 31.

A class in school gardens from the Teachers' College, conducted by Mr. H. C. Irish, visited the Garden on April 21.

On April 10, pupils of the Ritenaur School, Overland Park, St. Louis County, conducted by Miss Hortense Reith, visited the Garden.

Dr. B. M. Duggar, Physiologist to the Garden, gave a talk on "Mushroom Growing," at the meeting of the Garden Students' Club, on April 16.

Dr. E. J. Durand, of Missouri University, recently spent a day or two at the Garden consulting the herbarium and the collection of exsiccati.

Dr. George T. Moore, Director of the Garden, spoke before the St. Louis Y. M. C. A., Central Branch, February 26, on "Agriculture as a Life Work."

Professor B. L. Robinson, Professor of Systematic Botany and Curator of the Gray Herbarium, of Harvard University, visited the Garden on April 26 and 27.

A collection of fancy Japanese fan-tail goldfish, presented to the Garden by Mr. C. B. Nicholson of Clifton Heights, is temporarily shown in the nepenthes pond.

On March 22, Dr. George T. Moore spoke before the Railroad Branch Y. M. C. A. on "The Missouri Botanical Garden and its Service to the City."

At the March meeting of the Missouri Botanical Garden Students' Club, the following officers were elected: President, C. F. Geibel; Vice-President, P. A. Pfaender; Secretary and Treasurer, P. A. Kohl.

On April 1, Mr. C. H. Thompson, Assistant Botanist to the Garden, gave an illustrated talk before the Mothers' Circle of the Horace Mann School on "Popular Educational Features of the Missouri Botanical Garden."

Dr. Edwin C. Miller of Kansas State Agricultural College, Manhattan, Kansas, visited the Garden the week of March 22–27, and on March 26 lectured to the staff and graduate students on his experimental work in connection with the weather requirements for crops in the Great Plains area.

STATISTICAL INFORMATION FOR MARCH, 1915

GARDEN ATTENDANCE:

Total number of visitors	4,534

PLANT ACCESSIONS:

Total number of plants received in exchange	794
Total number of seed packets received in exchange	89

LIBRARY ACCESSIONS:

Total number of books bought	12
Total number of books and pamphlets donated	103

HERBARIUM ACCESSIONS:

By Purchase—	
F. S. Collins — "Phycotheca Boreali — Americana," Nos. 2001–2050	50
Miss Charlotte C. Ellis—Plants of New Mexico	395
By Gift—	
F. D. Bailey—*Cyphella oregana*	1
S. H. Burnham—Specimens of fungi	2
J. A. Drushel—Flowering plants from Missouri and Ohio	11
B. M. Duggar—*Thelephora terrestris* from France	1
H. S. Fawcett—*Septobasidium canescens* from California	1
W. H. Lang—Specimens of timber-destroying fungi from the Southwest	19
R. L. Latham—Specimens of fungi from Long Island, N. Y.	9
L. O. Overholts—*Tricholoma permagna* Murr. from Tolland, Colorado	1
C. E. Owens—Specimens of fungi from Oregon	5
L. Romell—Specimens of fungi from Sweden and New York.	3
H. von Schrenk—Specimens of fungi from Florida	14
H. von Schrenk—*Bauhinia variegata* var. *purpurea* L. from Florida	1
W. A. Setchell—Fungi from California and Washington	19
F. C. Wolf—*Setobasidium pedicellatum* on living orange leaves from Florida	1
S. M. Zeller—Specimens of *Stereum* and *Thelephora* from Seattle, Washington	7
TOTAL	540

The Garden is open to the public week days the year 'round from 8:00 A. M. until one-half hour after sunset. Until November 30, the Garden will be open Sundays from 2:00 P. M. until sunset. Admission free.

Personally conducted trips through the Garden every Saturday afternoon from May 1 to November 1, starting from the main gate at 3 o'clock. Other trips may be arranged for by special appointment.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

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Assistant to the Director,

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BENJAMIN MINGE DUGGAR,
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J. ERDMAN,
Plant Propagation.

W. F. LANGAN,
Engineer.

C. R. FOLLEN,
Construction.

G. H. PRING,
Orchids and other Exotics.

P. FOERSTER,
Farm and Stables.

M. SCHILLER,
New Conservatories.

C. W. GARRETT,
Outside Floral Displays.

K. N. SVETLIKOFF,
Plant Breeding and Seeds.

MISSOURI BOTANICAL GARDEN BULLETIN

Vol. III MAY, 1915 No. 5

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GROUP OF INSECTIVOROUS PLANTS

SARRACENIA

DROSERA

DIONAEA

PINGUICULA

Missouri Botanical Garden Bulletin

Vol. III St. Louis, Mo., May, 1915 No. 5

INSECTIVOROUS PLANTS

The destruction of vegetable life by the voracious attacks of insects is well known, but that there are certain plants which obtain important elements of their food from insects which they have caught in one way or another is not so widely appreciated. Representatives of this group of remarkably specialized plants are now to be seen on exhibit in the north vestibule of the Nepenthes House.

A number of plants show contrivances which obviously have for their function the capture and retention of such small creatures as may fly or creep upon their leaves; and it has been ascertained by experiments that the majority of these plants use the animals they capture, in one way or another, as sources of food. For the most part the plants in question prey upon insects, and hence the term "insectivorous plants" has been rather generally applied to them; it has been estimated that there are now known about five hundred such plants.

By a consideration of the special adaptations for capturing insects, these plants naturally group themselves into three distinct sections, two of which are represented in the collection at the Garden. The first section contains those forms in which chambers are developed into which small animals may enter, but from which it is impossible for them to escape. These plants exhibit no movement of any kind. To this group belong the genera Nepenthes[1] and Sarracenia, of which a number of species are on exhibit. The second section embraces those forms which show a definite movement designed to cover the prey with as great a quantity of digestive fluid as possible, a movement which may in some cases, as in Dionaea, also serve to capture the insects. To this section belong the genera Pinguicula, Drosera, and Dionaea. Many representatives of these, too, are in the collection. The third

[1] An account of these interesting plants and the collection at the Garden may be found in the October, 1913, number of the BULLETIN.

section, of which the Garden at present has no representatives, includes those forms which neither have pitfalls nor exhibit movement of any kind, but whose leaves are covered with a mucilaginous substance in which insects become entangled, later to be digested by the plants.

Species of Sarracenia, variously known as sidesaddle-flower, American pitcher-plant, and trumpetleaf, are found growing in peat-bogs in the eastern United States and in Canada. In these species the rim about the mouth of the trumpet-shaped leafstalk is somewhat swollen and curved outward and downward. Above this orifice the leaf-blade is arched to form a cover for the so-called pitcher. Both this cover and the upper portion of the trumpet are highly colored, in which respect they serve to attract insects in the same manner as do flowers. At the mouth of the pitcher and on the under side of the lid, honey is secreted in great abundance. On the areas where honey occurs are found innumerable fine, smooth, conical projections directed downward, becoming gradually longer toward the bottom of the trumpet. Insects are attracted by the bright colored lid and are lured on by the honey; when they reach the slippery deflexed points they are unable to hold themselves, and every effort to climb up these points only causes the insects to slide farther and farther downward to the bottom of the trumpet, where they are soon killed and ultimately decomposed in the fluids secreted within the chamber. Whether this decomposition, or digestion, is effected merely by putrefactive bacteria, or whether it is due to the presence of digestive enzymes, or ferments, secreted by the plant, appears to be a matter of question; it is certain, however, that the products of decomposition are absorbed by the plant to serve as food, especially the nitrogenous sorts.

The genus Nepenthes, comprising the true pitcher-plants, is represented by about thirty-six species. It is a native of the tropical region extending from India through the East India Islands to Australia. In habit it is a vine which climbs, by its leaves, among the under-shrubs and small trees that overhang the margin of pools in shaded damp jungles. In these plants the leaf is much more modified than in the species of Sarracenia. The lower portion of the petiole is winged and expanded laterally like a typical leaf, whereas the middle portion is small and cylindrical and acts as a tendril. By coiling about the twigs of adjacent shrubs or trees the plant is enabled to climb, and at the same time these supports assist in carrying the weight of the pitcher, which forms the third section of the petiole. The leaf-blade proper is represented by a small ovate structure which closely

covers the orifice of young pitchers but lifts as a hinged lid when the pitcher is matured.[1]

The pitchers vary in size from one and one-half to twenty inches in height. For the most part they are highly colored, displaying a yellowish green ground, marbled and veined with purple. Many are of a bluish, violet, or rose tint near the orifice, or sometimes dark red; from a distance they have the appearance of flowers, and, like flowers, are sought by insects. Furthermore, they secrete an abundance of nectar from the under surface of the lid and on the rim about the mouth of the pitcher. Insects which sip this nectar wander only too readily to the interior of the orifice. Here the inner face is smooth and so slippery as to afford no foothold, and the insect slips down to the bottom of the pitcher into the secreted liquid, and ultimately perishes.

The liquid, which fills one-third to one-half of the cavity, is secreted by special gland-cells on the inner surface of the pitcher, is of a slimy, tasteless character and gives a neutral reaction. As soon, however, as an animal's body comes in contact with it, or even as the result of a mechanical stimulus, the reaction of the liquid is rendered acid, and in this condition the fluid possesses the power of dissolving albuminous substances, such as flesh and coagulated blood, functioning, therefore, like the gastric juice of the animal's stomach. Furthermore, the products of the digestion appear to be promptly absorbed by the leaf. The process taking place when animals fall into the liquid contained in the pitchers of the Nepenthes species may therefore be properly designated as digestive.

Pinguicula, or butterwort, is native to the Arctic and Subarctic regions and the high mountains of the temperate zone. The leaves form a rosette, the under surface of which rests upon the wet ground. The margins of the leaves are somewhat upturned so as to form a broad flat-bottomed trough, and the upper surface is covered with innumerable microscopic glands which secrete a colorless, sticky liquid in great abundance. The latter acts as a trap in the same manner as sticky fly-paper. When an insect becomes entangled in the mucilage covering of the leaf the glands are forthwith stimulated to a more profuse secretion of fluid, which has an acid reaction and contains a protein digesting enzyme, or ferment, the conditions apparently being much like those in the pitcher-plant. At the same time the margins of the leaf gradually roll upward and inward, forcing the insect toward

[1] A good illustration of one of the specimens in the Garden accompanies the article on Nepenthes in the October, 1913, number of the BULLETIN.

the center of the leaf as well as bringing more secreting glands in contact with it. Besides small insects, spores, pollen-grains, and other plant substances brought by the wind not infrequently fall on the viscid surface of the leaf, are digested, and the soluble portions are absorbed.

Drosera, the sundew, of which almost forty species are known, thrives in practically the same regions as the butterwort, and frequently the two are found growing in the same area. That which impresses one most at first sight of this plant is the presence of the delicate bristles, on the upper surface and margin of the leaf, each bristle surmounted by a tiny drop of fluid, which sparkles in the sunlight like a drop of dew, whence the name "sundew." At the extremity of each bristle is a gland which secretes this clear, sticky matter whose function is essentially the same as that of the glands on the leaf of the butterwort. When a small insect alights on the leaf and touches the glands there ensues an increase in the discharge of fluid, which now is acid and contains in addition a protein digesting enzyme, or ferment. The insect is caught by the sticky juice, and in trying to liberate itself, becomes besmeared with the secretion, the latter greatly impeding its movements. The breathing organs are soon covered, and after a brief interval, during which all efforts on the part of the captive to escape cease, the insect dies of suffocation. All these phenomena correspond, in the main, to those occasioned by similar causes in the case of the butterwort. The leaves of the sundew, however, are especially characterized by the movements of the tentacle-like bristles in response to a stimulus by animal matter. When an insect becomes secured by the mucilaginous glands, a stimulus is conveyed to the nearest neighboring tentacles, and gradually to those farther away, with the result that the tentacles, in regular order, begin to bend inward toward the point where the insect has become entangled, and converge upon it so as to cover it completely. When the captured insect is comparatively large the leaf itself folds over it. These movements bring a very large number of the digestive glands in contact with the insect, and the copious supply of digestive fluid secreted promptly acts upon the animal body present, digesting certain constituents and rendering them fit for absorption by the plant.

Dionaea, Venus' fly-trap, is native to but one restricted locality near Wilmington, North Carolina, in the vicinity of peat-bogs. The leaves, like those of many other carnivorous plants, are grouped in rosettes, and rest, for the most part, entirely or partially upon the ground. Each leaf consists (1) of a flat paddle-shaped petiole abruptly ending in

a narrow neck, and (2) of a roundish leaf-blade. The latter is divided into two symmetrical halves inclined to one another like the sides of a half-open book. Both margins of the leaf-blade are provided with a fringe of from twelve to twenty long, sharp, slender teeth. At the center of the upper surface of each half of the leaf-blade there are three very stiff and sharp spines standing up obliquely. In addition to these processes, microscopic glands capable of secreting a mucilaginous liquid are scattered over the whole upper, or inner, surface of the leaf-blade. As soon as one of the six stiff bristles on the two faces of the leaf-blade is touched ever so lightly, the leaf shuts up instantaneously, an action not unlike the quick closing of a half-open book. The sharp marginal teeth are interlocked and the body that touched the bristle is enclosed within.

If this body has no food value, the leaf soon opens again, but if it has such value the two lobes of the leaf remain closed over the object for a long period. The sides are pressed together so tightly that the intervening body, if soft, is squeezed and crushed to pieces. In addition, the glands which are dry so long as the leaf-blade remains open, begin to secrete a slimy, colorless, and highly acid juice with digestive properties. The secretion flows so copiously that it covers the imprisoned body and gradually dissolves, or digests, the contained albuminous compounds, the soluble products of the digestion afterwards being absorbed by the same glands which secreted the acid digestive liquid. After digestion and absorption, the trap opens, the glands become dry, the parts assume their former positions, and the leaf is once more equipped for making fresh captures.

Among the five hundred or more species of insectivorous plants now known there is a wide range of botanical relationship, several widely separated families being represented. Their habits of growth, too, are varied, adapting them to various climatic conditions. Some have their traps wholly submerged in water and depend for their food upon the minute animal life in the water. Others, like those enumerated above, thrive only in moist locations. Still another species is to be found indigenous to arid regions only.

GRADUATE RESEARCH WORK AT THE GARDEN

More than two years ago—in the March, 1913, number of the BULLETIN—a brief account was given of the laboratories in which are conducted the experimental and research work of staff and graduate students. Work of this type, as a rule, does not come to the attention of the casual visitor. More-

over, even those who are sufficiently interested and informed to suspect that the unusual facilities afforded at the Garden would attract serious students of botany are invariably surprised to learn of the nature and extent of the work undertaken in the Graduate Laboratory. It has seemed well, therefore, from time to time to make some statements regarding the advanced work, from which, perhaps, those interested may derive a more definite idea of its relation to scientific investigation in general and to the progress of botanical science in particular.

In the present discussion it is not intended to include any record of the investigations now in progress by members of the permanent staff, but merely those of graduate students, most of whom are presenting the results of their investigations as theses in partial satisfaction of the requirements for the degree of Doctor of Philosophy in Washington University.

Botanical Investigation is Comprehensive and Practical.—At the outset it may be well to recall that there are apparently still some who assume that the training of a botanist consists merely in cultivating an appreciation of the beauty of flowers and in acquiring a naming acquaintanceship with local floras. The serious study of the classification of plants has been important since the beginning of the science, and it will remain so; knowledge of form and structure (morphology) is likewise a fundamental phase of the work; but to-day investigation is being directed to an amazing degree along lines throwing light upon the living activities and life relations of plants, including plant pathology. Now the living processes and responses of plants, as far as they can be investigated, are governed by the laws of chemistry and physics, so that much of the fundamental work in plant physiology consists in ascertaining the chemics and physics of the living organism. The problems which the physiologists and pathologists study in connection with the cells and tissues of plants are parallel to those studied on the animal side, and the general principles developed in one field are in the great majority of cases applicable to the other.

It would be most erroneous to gain the impression that the study of plant cells contributes nothing to medicine and less to general biology than does zoölogy. As a matter of fact, aside from the paramount importance of botanical investigations in agriculture and forestry, innumerable relations to the development of animal physiology and pathology, as well as to chemistry, could be pointed out. Mention may be made here of the fact that Pasteur's studies on the function of the yeast cell in alcoholic fermentation did not at

the time seem to have the remotest connection with problems of human diseases, yet this discovery was undoubtedly the most important single contributing impulse leading to the discovery of the rôle of micro-organisms in diseases. Pfeffer's measurements of the osmotic pressure of solutions of cane sugar and De Vries' studies of the pressures in plant cells threw fundamental light upon the movements of substances and solutions in all tissues as well as led to the development of new laws in physical chemistry. Facts derived from a study of the nutrition of micro-organisms have not infrequently been made the basis of improved methods of feeding in the case of certain human diseases.

A present day department of botany with complete facilities for research in all fields has no exact counterpart on the animal side. Frequently all phases of animal physiology, pathology, and chemistry are included in the departments of the medical school, but in plant work these important phases are all grouped together as one subject along with the older subdivisions of botany. It is, therefore, obvious that the work is comparable to that of a group of research departments.

An Electrical Method for Determining Root Excretion.—Visitors to the Garden have seen peas and other plants in the experimental greenhouse growing with their roots in tumblers of solutions and they have doubtless wondered what the object was in growing plants in that manner. In explanation it may be said that the water culture, or solution method, is indispensable for many purposes, and Mr. M. C. Merrill, Research Assistant, has employed it in the investigation described below.

To determine what mineral nutrients, or inorganic salts, are absolutely necessary or desirable for the growth of plants, the method is to place the roots of the seedling plants to be tested into pure distilled water to which have been added various salts. By withholding each substance, or salt, in turn from similar cultures under observation at the same time, it can be found which are essential, or what happens when the solution is variously "unbalanced." Obviously, soil cultures would not serve the purpose. Now the roots, or more especially the root hairs on the younger parts of the roots, absorb water and salts in solution from the medium in which they are growing, and this important process of absorption, or endosmosis, as it is termed, has necessitated much study. Less attention has been given to the opposite process,—which may be a very important one, too—that of the outflow of salts and other substances from the roots into the surrounding medium, a process designated as exosmosis. One com-

mon example of this phenomenon is the excretion of carbon dioxide by the roots, whereby even such resistant rocks as marble are corroded and dissolved. In recent years the Bureau of Soils of the U. S. Department of Agriculture has advanced the idea that the poor growth of a crop on any given soil may not be due so much to lack of plant food as to the presence of toxic substances arising from the roots of the previous crop. In general, though, the amount of any excretion from the roots must be very small.

The purpose of the investigation here reported was to determine by electrical means the relative amount of exosmosis, or excretion, when the plants were subjected to various conditions. This was done by measuring the electrical conductivity, or resistance, of the water before, during, and after the roots had been in it for varying periods. Water that is pure from a chemical standpoint has a very low conductivity, or high resistance, i.e., the electric current passes through it only with difficulty. On adding salts, etc., to the water its conductivity increases enormously, hence the measurement of the conductivity is likewise a measure of the amount of substances which passes from the roots into the water; so that in these experiments it is an indication of the excretion from the roots. Of course, if the roots are killed, the loss of substances from them is very rapid. In these experiments, however, it was especially desired to ascertain if unfavorable conditions and injurious agents would cause any appreciable excretion.

Some of the plants were accordingly subjected to illuminating gas, toxic agents, extremes of temperature, and even anesthetics and as a result of the tests a definite exosmosis was found (variable with the treatment) even when the treatment had not been severe or prolonged enough to seriously affect the plant in its external appearance. With these facts before us—and in such detail as they have been worked out—it is believed that we can better determine the nature and effects of unfavorable field conditions. The work suggests many new lines of investigation.

Digestive Ferments of the Marine Algae.—As a result of the connection of the Garden, through certain members of its staff, with the Marine Biological Laboratory, at Woods Hole, Massachusetts, some relations of the marine algae have been studied, and especially the digestive processes of these organisms have offered some attractive problems. The transformation of food within the plant is known to be brought about in a way very similar to that in the animal organism, —in most cases the same kind of digestive substances or enzymes being involved. We know quite well how the com-

mon accumulation products of most plant tissues, such as starch and sugar, are digested by the cell, but preliminary experiments seemed to indicate that somewhat unexpected conditions might prevail in certain algae, and Mr. A. R. Davis, Rufus J. Lackland Fellow, has investigated the general question of ferment action, or the digestive processes, in the marine algae. Any new knowledge concerning the way in which the various ferments, or enzymes, act, whether the information be gained through investigation of plant or animal tissues, throws light upon the general problems of digestion. It was to gain new facts concerning the broader phases of the subject as well as to study intimately the particular nature of such enzyme action in the seaweeds that this research was undertaken. The seaweeds, or algae, were chosen because so little has been known concerning the digestion changes occurring in these plants.

The enzymes were isolated from the tissues by standard methods, and when so isolated were brought into solutions or infusions with certain organic compounds to determine if the latter were then digested. If, for example, a starch paste were digested, that would indicate that a starch-digesting enzyme is produced by the plant. Again, the rates at which such enzymes would carry on a digestive process were compared in several instances with the rates evidenced by enzymes obtained from some of the flowering plants. In general, digestive activities were found to proceed much more slowly in the algae, and the actual number of enzymes demonstrable proved to be considerably less than those in other plants. One of the most important points resulting from the work is the indication of the existence of certain inhibiting agents, which upon the death of the cell may unite with the enzymes and thus preclude its further work as an active digestive ferment.

Yeast Fungi in Relation to Animal Diseases.—Considerable differences of opinion have existed regarding the rôle of wild yeasts and certain other related fungi to occasional cases of animal diseases. Following the isolation of a species of yeast under suggestive conditions from a human tumor, Mr. W. H. Emig, formerly Rufus J. Lackland Fellow, secured cultures of wild yeasts from innumerable natural sources and sought to determine the possibility of their pathogenicity as regards warm-blooded animals. At considerable labor more than 3,000 cultures were made and all yeasts thus obtained were tested with respect to their growth on blood serum, the feeling being that those organisms which would not grow on the serum could scarcely be regarded as worthy of further attention from a pathogenic standpoint. Some

interesting organisms were found, but among the many isolated, only 12 species grew upon the serum at 37°C; and upon making the requisite animal inoculations it was found that two species produced slight lesions, but perhaps insufficient to be considered of primary pathogenic importance. The cultural characteristics of the more interesting organisms found were studied and described.

An Important Cabbage Disease.—Mr. J. C. Gilman, Rufus J. Lackland Fellow, was occupied for a year or more at the University of Wisconsin, and for a year at the Garden, with a general study of an important cabbage disease. While engaged in the selection of a variety of cabbage resistant to the "yellows"—a very destructive disease of this important crop—it was thought advisable to undertake investigations to determine the conditions under which the disease occurred. The cause of the disease was found to be a fungus (*Fusarium conglutinans*) which lived saprophytically in the soil and became parasitic on the cabbage plant through the roots. The fungus then grew into the water-conducting tissue of the cabbage and ultimately killed the plant, perhaps by slow stoppage of the water supply. The fungus was studied in pure culture and in the field. It was found to be resistant to drying and to require a rather high temperature for its best development in culture. Detailed observations in the field indicate that warm weather is at least a strongly predisposing cause. Experiments under controlled conditions of temperature in the greenhouse confirmed these observations. The disease occurred at temperatures of 17–22°C. or above, but was not found when the temperature was kept at 12–16°C. or below. No remedial measures have been devised, but other work has shown that highly resistant strains of cabbage may be selected.

The Relation of Resin and Turpentine to Wood Decay.—Recently much interest has been aroused among lumbermen concerning specifications for structural timber, the requirements of which are strength and durability. The strength depends upon the specific weight of the wood, but the natural factors which control the durability or resistance of wood to the growth and development of wood-decaying fungi present an open question. The Yellow Pine Manufacturers Association has heretofore considered the growth rings as indices both of strength and durability of the timber, based upon the proportion of summer wood and number of rings per inch. The rings of growth are composed of layers of dense, dark, usually resinous summer wood and softer, lighter, less resinous spring wood, and the greater the percentage of summer wood the greater the strength and durability of the

timber. It has been considered that the resin content is the important index of durability, and for this reason it is believed that the durability of shortleaf pine lumber having the required percentage of summer wood is uncertain. With the coöperation of the Yellow Pine Manufacturers Association, Mr. S. M. Zeller began an investigation last fall at the Graduate Laboratory to determine the relationships which the percentages of resin, turpentine, and wood fiber in longleaf pine (*Pinus palustris*), shortleaf pine (*P. echinata*), and loblolly pine (*P. Taeda*) bear to the resistance of the wood toward fungous decay. The soluble ferments of the fungi used in the work will be studied. This work will be continued throughout the summer months and during the coming academic year.

The Classification of Certain Polypores.—The Polyporaceae form a very natural group of plants commonly called the "pore fungi," "bracket fungi," "punks," "conchs," etc. They are mostly tough or woody growths appearing upon trunks and stumps of trees in woods and groves. Very often they grow upon living trees and may at times be a considerable menace to the life of the tree. In other cases they are found on structural timbers and may cause very destructive rots of the wood. The treatment of such timbers so as to prevent the entrance of the fungi forms an important industry in itself, and is a subject to which the railroads, especially, have given much attention of late years, owing to the prevalence of the fungi mentioned as the chief agents in the destruction of railroad ties and bridge timbers.

More or less confusion still reigns regarding the classification of this group of plants, and Mr. L. O. Overholts, Rufus J. Lackland Fellow, has found that the species of this group afford some interesting taxonomic problems. The use of the microscope in the study of the internal characters of the pore fungi is a recent introduction, and has aided immensely in clearing up obscure points regarding the relationships of species within the group. Many of our common species are still in need of work of this kind. The investigation so far has been concerned with checking up the microscopic characters of these plants. In several instances the characters defined in the literature dealing with these plants have been shown to be erroneous, and in some cases hitherto unknown characters have been added to the list, thus aiding considerably in fixing more definitely the limits of the species.

Research and Its Applications.—The immediate application of scientific work is by no means the first consideration, but sympathy with the general idea of relating the work to human affairs is also broadening and stimulating. That the

staff of the Missouri Botanical Garden are in ample accord with this idea is shown by their association with practical problems, among which may be mentioned these: to Dr. Moore is due the copper treatment of reservoirs, and water supplies, as well as a wider application of the value of copper salts as disinfectants; to Dr. Duggar, practical studies in the fungi, including contributions on plant diseases and methods for mushroom culture and spawn making; to Dr. von Schrenk, the study of decay-producing fungi and the development of methods of wood treatment or impregnation for the prevention of decay in structural and other timbers; to Dr. Hill, a clearer conception of the value of ventilation in the shipment and storage of perishable fruits and vegetables; to Mr. Nolte, the perfection of a definite method of analyzing air for the detection of its polluting organisms. In common with biological progress generally, however, the development of our knowledge of plant life depends upon a clear atmosphere of research and freedom of inquiry. With this condition established, and with the understanding that practical experimentation is costly, it is more likely that in the present era the applications of botanical science will always illuminate rather than obscure the domain of investigation.

FLORAL DISPLAYS

Conservatories.—A large and varied collection of snapdragons, or antirrhinums, and equally large and varied collections of gloxinias and calceolarias with a scattering of *Lilium rubrum* and calla lilies have made the Floral Display House during the month of May a place of gay colors and beautiful flower forms. These flowers will gradually give place to larger collections of lilies and the many varieties and shades of French hydrangeas. A collection of fuchsias and specimens of the little blue daisy (*Felicia amelloides*), together with yellow and white marguerites and some senecios, will complete the floral display for the month of June, while large groups of foliage plants, such as coleus, crotons, and fancy-leaved caladiums, will make an effective setting for the bright colored flowers. In order to facilitate its conversion into a house for the large collection of succulents, the Floral Display House will be closed to the public during the summer months.

Rose Garden.—The rose garden[1] of last season has been considerably enlarged by the addition of some fifty beds to the south of the pergola. These beds have been planted with the following varieties of roses:

[1] See article in March, 1914, number of the BULLETIN for further information concerning the rose garden.

Gruss an Teplitz
Frau Karl Druschki
Laurent Carle
White Killarney
Harvey Kirk
Antoine Rivoire
Lady Ashtown
Mad. Leon Poin
Miss Cynthia Forde
Jonkheer J. L. Mock
Lady Alice Stanley
La France
Betty
Souv. de Pres. Carnot
Mad. Ravary
Duchess of Wellington
General McArthur

Some 1,300 new plants were added to the collection in planting the above new section, but some time will be necessary before these beds attain the effectiveness of those in the older part of the rose garden.

In this garden quite a number of the roses had begun to bloom freely as early as the middle of May, among which were the following:

Helen Gould
Lady Ashtown
Otto von Bismarck
Katherine Zeimet
Frau Karl Druschki
Magna Charta
Jean Libaud
Rodhatte
Geo. C. Waud
Clio
Duke of Teck
Hugh Dickson
Mad. Jules Grolez
Beaute de Lyon
Tom Wood

Many additions to the above list will appear during the month of June, including a large collection of ramblers.

NOTES

Two classes from the Ashland School were conducted through the Garden on April 30.

Mr. Henry Ochs, a graduate of the Garden course, visited the Garden on April 15. Mr. Ochs is now studying medicine.

The Annual Flower Sermon, provided for in Mr. Shaw's will, was preached in Christ Church Cathedral by the Rev. A. A. V. Binnington, on May 16.

Mr. J. Hollister Tull, a former Garden pupil, was a visitor at the Garden on May 24. Mr. Tull is now Agriculturist for the Kansas City Southern Railroad, at Mena, Arkansas.

Mr. C. H. Thompson, Assistant Botanist to the Garden, gave an illustrated talk before the Garden Club of Webster Groves, April 22, on "Flowers and Insects."

Miss Marjorie F. Warner, who is engaged in bibliographical work in the U. S. Department of Agriculture, Washington, D. C., has been noting early agricultural and horticultural books in the Garden Library for a fortnight.

Prof. E. D. Merrill, Botanist of the Philippine Bureau of Science, spent a few days at the Garden about the middle of May. On May 12, he addressed the staff and graduate students on some aspects of the botanical work in the Philippines.

On May 18, the Commercial Commissioners of China, accompanied by representatives of the Business Men's League of St. Louis, visited the Garden and were conducted through the grounds. Much interest was displayed by the visitors in the insectivorous plants as well as in the plants indigenous to China.

The Washington University Chapter of the Society of the Sigma Xi held its annual banquet for the initiation of new members on May 20. Dr. E. A. Burt, Mycologist and Librarian to the Garden and Associate Professor of Botany in Washington University, Mr. G. W. Freiburg and Mr. R. A. Studhalter, Rufus J. Lackland Research Fellows, and Mr. W. W. Bonns, appointed Rufus J. Lackland Fellow for 1915-16, were among the new members initiated.

Recent visitors to the Garden include Dr. Wm. Trelease, Professor of Botany, University of Illinois; Dr. F. P. Mall, Professor of Anatomy, Johns Hopkins University; Dr. A. G. Johnson of the University of Wisconsin; Dr. L. J. Cole, Professor of Experimental Breeding, College of Agriculture, University of Wisconsin; Dr. H. A. Harding, Chief of the Division of Dairy Husbandry, University of Illinois, and Dr. Wm. Howell, Professor of Physiology, Johns Hopkins University.

Dr. George T. Moore, Director of the Garden, attended the Twenty-fifth Anniversary of the Nebraska Academy of Sciences, on May 21, as the official delegate of the Missouri Botanical Garden, the Academy of Science of St. Louis, the Indiana Academy of Science, and the Academy of Natural Sciences of Philadelphia. He spoke at the memorial service for the late Dr. Charles E. Bessey, and gave an illustrated lecture on "The Missouri Botanical Garden as a Scientific Institution."

The Rufus J. Lackland Research Fellowships for the year 1915-1916 have been awarded to the following:

Mr. R. A. Studhalter, A.B., University of Texas, 1912, reappointed.

Mr. George W. Freiburg, B.S., South Dakota State College, 1913, reappointed.

Mr. W. W. Bonns, B.S., Massachusetts Institute of Technology, 1899; B.S.A., Cornell University, 1909; Assistant

Professor of Pomology, University of California Citrus Experiment Station, 1912—.

Carroll W. Dodge, A.B., Middlebury College, 1915; Teacher of Elementary Botany, Middlebury High School.

Harry C. Young, B.S., Ohio State University, 1913; M.S., Agricultural and Mechanics College of North Carolina, 1915; Instructor in Botany, A. and M. College of North Carolina; and teacher of Plant Physiology, A. and M. summer school.

Mr. Alva R. Davis, Rufus J. Lackland Research Fellow, has been appointed Research Assistant to succeed Mr. M. C. Merrill, and Mr. Joseph Warren Severy, A.B., Oberlin College, 1915, has been appointed Teaching Fellow in the Shaw School of Botany, to succeed Mr. F. B. Wann.

The issue of the Annals of the Missouri Botanical Garden containing the Anniversary proceedings, and constituting the first and second numbers of Volume II, has been issued with the following contents:

"The Twenty-fifth Anniversary Celebration."

"The Vegetation of Mona Island." N. L. Britton, *New York Botanical Garden.*

"The Flora of Norway and its Immigration." N. Wille, *Professor at the Christiania University.*

"The Phylogenetic Taxonomy of Flowering Plants." Charles E. Bessey, *University of Nebraska.*

"The Botanical Garden of Oaxaca." C. Conzatti, *Director of the Botanical Garden of Oaxaca, Mexico.*

"The Origin of Monocotyledony." J. M. Coulter, *University of Chicago.*

"The History and Functions of Botanic Gardens." Arthur W. Hill, *Assistant Director, Royal Botanic Gardens, Kew.*

"Recent Investigations on the Protoplasm of Plant Cells and its Colloidal Properties." Frederick Czapek, *Pflanzenphysiologisches Institut der K. K. Deutschen Universität, Prague, Austria.*

"The Experimental Modification of Germ-Plasm." D. T. MacDougal, *Department of Botanical Research, Carnegie Institution of Washington.*

"The Relations between Scientific Botany and Phytopathology." O. Appel, *Mitglied der Kaiserlichen Biologischen Anstalt für Land- und Forstwirtschaft, Berlin-Dahlem.*

"The Law of Temperature connected with the Distribution of the Marine Algae." W. A. Setchell, *University of California.*

"Phytopathology in the Tropics." Johanna Westerdijk, *Director of the Phytopathological Laboratory, Amsterdam, Holland.*

"Phylogeny and Relationships in the Ascomycetes." Geo. F. Atkinson, *Cornell University.*

"A Conspectus of Bacterial Diseases of Plants." Erwin F. Smith, *U. S. Department of Agriculture, Washington, D. C.*

STATISTICAL INFORMATION FOR APRIL, 1915

GARDEN ATTENDANCE:

Total number of visitors	40,710

PLANT ACCESSIONS:

Total number of plants received in exchange	162
Total number of seed packets received in exchange	390
Plants donated	1

PLANT DISTRIBUTION:

By Gift	200

LIBRARY ACCESSIONS:

Total number of books bought	9
Total number of books and pamphlets donated	180

HERBARIUM ACCESSIONS:

By Purchase —

E. Bartholomew—"North American Uredinales," Cent. XIV, Nos. 1301-1400; and "Fungi Columbiani," Cent. XLVI, Nos. 4501-4600	200
T. Brandegee—Plants of Mexico, collected by C. A. Purpus in 1914	230
L. O. Overholts—Plants of Colorado	70
T. O. Weigel—Plants of the Philippine Islands collected by Father Morice Vanoverbergh	78
T. O. Weigel—"Plantae Kamerunenses," Cent. VI, Nos. 500-599	100

By Gift —

Mrs. M. S. Chapman—Specimens of fungi from Vermont	2
J. M. Coulter—*Hesperocallis undulata* Gray from California.	1
J. A. Drushel—Plants of Ohio, Illinois, and Missouri	12
W. G. Farlow—Specimens of fungi	5
Philip Garmen—*Septobasidium pedicellatum* from Kentucky.	1
A. H. Gilbert—*Septobasidium pedicellatum* on apple twigs from Kentucky	1
W. C. Le Van—*Podophyllum peltatum* L. from Oklahoma	1
E. O. Matthews—Fungi, lichens, and mosses from Mexico	18
L. O. Overholts—Specimens of Missouri fungi	23
Lars Romell—*Peniophora Allescheri* from Sweden	1
W. A. Setchell—Specimens of fungi from California	2
G. W. Stevens—Fragment of *Senecio filifolius* Nutt. from Oklahoma	1
J. R. Weir—Fungi from Montana, Idaho, British Columbia, and Alaska	100
TOTAL	846

The Garden is open to the public week days the year 'round from 8:00 A. M. until one-half hour after sunset. Until November 30, the Garden will be open Sundays from 2:00 P. M. until sunset. Admission free.

Personally conducted trips through the Garden every Saturday afternoon from May 1 to November 1, starting from the main gate at 3 o'clock. Other trips may be arranged for by special appointment.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

The Garden will be open all day on Decoration Day, May 31.

STAFF
OF THE MISSOURI BOTANICAL GARDEN

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GEORGE T. MOORE.

Assistant to the Director,

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BENJAMIN MINGE DUGGAR,
Physiologist, in charge of Graduate Laboratory.

EDWARD A. BURT,
Mycologist and Librarian.

HERMANN VON SCHRENK,
Plant Pathologist.

CHARLES H. THOMPSON,
Assistant Botanist.

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Research Assistant.

JAMES GURNEY,
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Plant Propagation.

W. F. LANGAN,
Engineer.

C. R. FOLLEN,
Construction.

G. H. PRING,
Orchids and other Exotics.

P. FOERSTER,
Farm and Stables.

M. SCHILLER,
New Conservatories.

C. W. GARRETT,
Outside Floral Displays.

K. N. SVETLIKOFF,
Plant Breeding and Seeds.

MISSOURI BOTANICAL GARDEN BULLETIN

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Missouri Botanical Garden Bulletin

Vol. III St. Louis, Mo., June, 1915 No. 6

ROSES

In March, 1914, there was printed in the BULLETIN an article on rose growing in St. Louis which was so much in demand that the edition was soon exhausted. This year the interest in roses is even greater, and because of the demand for information concerning the best varieties to grow in this locality, and their care, it seems desirable that the substance of the previous article be reprinted. Considerable additional information has been added, however, and the account of the collection of roses at the Garden brought down to date.

The growing of roses in St. Louis does not require the extreme amount of skill that has generally been supposed. On the contrary, any one can grow roses successfully, provided a few general conditions of culture are understood and carefully observed. The idea has become general that owing to the adverse weather conditions prevalent during the summer months in this latitude, roses will bloom only during early summer and early fall. The experience with roses in the Garden, however, demonstrated beyond all question that with reasonable care any unfavorable climatic influences in St. Louis can be successfully overcome. Although the high temperature and droughts for the last two summers were particularly trying, the roses in the Garden presented an almost uninterrupted blooming period from early spring until late fall.

The prime requisite for rose growing in this locality is an abundance of water. If this is supplied, there will be no difficulty in getting continuous bloom, provided, of course, the proper kinds of roses are selected and the general directions given below are followed. While this account has been prepared with the roses in the Garden particularly in mind, it should apply equally well to any rose garden in St. Louis or vicinity.

THE ROSE GARDEN IN THE MISSOURI BOTANICAL GARDEN

The rose garden is located to the west of the administration and laboratory building and directly south of the old Shaw residence. The central feature of the garden is a large pergola upon a raised embankment, the north side of the latter being covered with four varieties of trailing roses. The pergola itself is gradually being overgrown with a number of climbing roses of the best sorts. The garden in general is conventional in design, being composed of numerous beds separated by straight and curved walks (see plan). About half of the beds lie to the north of the pergola and of the walk running through it, which connects the administration building with the medicinal garden. This path is marked on either side by occasional sentinel-like standard roses connected by hedges of other varieties. The east and south sides of the Garden are bordered by a hedge of "Clotilde Soupert" roses, dotted at intervals with iron posts upon which many varieties of climbing roses are growing. The entrances to the garden through this hedge are marked by arches, harmonizing in design with the pergola.

To the south of the pergola are a number of new beds containing some 1,300 plants, comprising about seventeen varieties which have been demonstrated as being among those which succeed best in St. Louis. While none of these plants is over three years old and most of them only two years old, they have already given an abundance of flowers this season.

MAKING A ROSE GARDEN

Location.—Roses are entitled to the choicest location in a yard. Good exposure to the sun, and proper protection from prevailing winds will do much to make the rose garden a success. While a location with a full-day sun exposure is much to be preferred, it is not absolutely essential, and where a choice must be made it is best to give roses the morning sun. Beds should not be located near trees or shrubbery. Roses are heavy feeders and for their best development require an unusual amount of fertilizer; when planted near trees or shrubbery, the roots of the latter deplete the soil of nourishment, with the result that the roses suffer. If, however, planting in close proximity to trees and shrubs is unavoidable, it is advisable each year to dig a trench (about a foot wide and two or three feet deep) around the rose bed and fill with well-rotted cow manure. This procedure will tend to prevent the roots of shrubs from actually entering the rose bed. Sometimes a concrete wall is constructed deep enough to prevent this encroachment.

Soil.—Roses usually do well in any good garden soil, but better results are obtained if considerable care is exercised in the preparation of the ground. Roses require a heavy, well-drained soil. To obtain this, the area to be used for a bed should be dug out to a depth of from eighteen inches to two feet, and if the drainage is not good another six inches should be removed and this space filled with fine broken stone, brick, or old flower-pots. Upon this porous stratum six inches of well-rotted cow manure should be placed, and finally sufficient heavy soil to finish the bed, raising it not more than three inches above the surrounding grade. This latter layer should, if possible, be top soil (including sod) from an old pasture. After making the bed it should be allowed to settle for a week before the planting is begun.

Planting.—Roses may be set out either in the fall or in the spring. The spacing depends very largely upon the variety; tea and hybrid tea varieties may be planted about eighteen inches apart, but hybrid perpetuals, on account of their more vigorous growth, should be spaced at least two and one-half feet, and ramblers eventually need about four feet. In any case an eight-inch margin from the edge of the bed should be allowed. Where potted stock is being planted, the ball of earth should be placed with its upper surface about two inches below the soil; field-grown stock may be set two or three inches lower than its former position in the nursery. The holes for receiving the plants should be large enough to admit the stock without bending or crowding the roots, the soil should be firmly packed around the roots, and the plants thoroughly watered immediately after planting. All stock should be so pruned that but two or three buds remain on each shoot—the upper bud, in each case, pointing outward.

Varieties to Plant.—Rose stock may be either grown on its own roots, or grafted or budded. It may be well in this connection, however, to call attention to certain disadvantages which attach to budded stock. In general, budded stock is more easily killed in severe winters than is stock grown on its own roots, and in addition the shoots which invariably spring from the parent stock frequently suppress the scion unless cut away. On the other hand, there are varieties of roses which it is impossible to grow satisfactorily unless they are budded on to a hardier stock.

Of the four or five thousand varieties of roses at present on the market, some growers list as many as eight hundred, but of these only a few grow to perfection in this latitude.

As the result of tests in the Garden from the standpoint of perfection of blooms, profuse flowering, and general hardiness, the following list of varieties has been prepared as being particularly desirable for planting in St. Louis and vicinity:[1]

Francisca Kruger (T.), coppery yellow
Perle des Jardins (T.), yellow
Maman Cochet (T.), silvery rose
Wm. R. Smith (T.), creamy white
Admiral Dewey (H.T.), light pink
Augustine Guinoisseau (H.T.), white, tinted with flesh pink
Bessie Brown (H.T.), creamy white
Betty (H.T.), rich gold
Chateau de Clos Vougeot (H.T.), velvety scarlet (the blackest rose)
Duchess of Wellington (H.T.), saffron yellow
Gruss an Teplitz (H.T.), bright scarlet crimson
Grace Molyneaux (H.T.), creamy apricot
George C. Waud (H.T.), orange-vermilion
General McArthur (H.T.), bright crimson
Killarney (H.T.), pink
Killarney (H.T.), white
Lady Ursula (H.T.), flesh-pink
La France (H.T.), brightest pink
Laurent Carle (H.T.), brilliant velvety carmine
Lady Ashtown (H.T.), pale rose
Liberty (H.T.), brilliant velvety crimson
Miss Cynthia Forde (H.T.), deep brilliant rose pink
Mrs. Aaron Ward (H.T.), Indian yellow
Mad. Jules Grolez (H.T.), satiny pink
Natalie Bottner (H.T.), pure white
Frau Karl Druschki (H.P.), snow white
Gloire Lyonnaise (H.T.), white, tinted with yellow
Magna Charta (H.P.), bright rose
Mad. Chas. Wood (H.P.), bright cherry-red
Hugh Dickson (H.P.), brilliant crimson
Paul Neyron (H.P.), rosy pink (one of the largest roses)
Clotilde Soupert (P.), flesh pink
Katherine Zeimet (P.), white
Mad. Norbert Levavasseur (P.), ruby-red
Orleans (P.), geranium-red
Hermosa (China), blush
Agrippina (China), fiery red
Belle Poitevine (Rugosa), rose
Blanc Double de Coubert (Rugosa), white
Conrad F. Meyer (Rugosa), silvery rose
Amy Robsart (sweetbrier), deep rose
Anne of Geierstein (sweetbrier), crimson
Meg. Merrilies (sweetbrier), crimson
Dorothy Perkins (climber), soft light pink
Dr. W. Van Fleet (climber), rich flesh
Excelsa (climber), crimson maroon
Flower of Fairfield (climber), crimson
White Dorothy Perkins (climber), white

A briefer list, with the varieties arranged according to habit, is likewise given for the benefit of those who may wish to try only a few of each kind:

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[1] In the following enumeration, tea, hybrid tea, polyantha, and hybrid perpetual varieties are respectively indicated by (T.), (H.T.), (P.), and (H.P.).

HYBRID TEA
(EVER-BLOOMING)

Gruss an Teplitz, scarlet crimson
Lady Ashtown, pale rose
Mad. Jules Grolez, bright china-rose
Indiana, red
La Detroit, shell pink
Ecarlate, scarlet
Lady Ursula, flesh pink
La France, bright pink rose
Augustine Guinoisseau (white La France)
Otto von Bismarck, bright rosy pink
Mrs. Aaron Ward, Indian yellow
Killarney, pink
Killarney, white
General McArthur, bright crimson
Duchess of Wellington, deep coppery yellow

HYBRID PERPETUAL, OR REMONTANT
(BLOOMING PERIOD 4-6 WEEKS)

Frau Karl Druschki, snow white
General Jacqueminot, brilliant scarlet-crimson
Magna Charta, bright rose
Ulrich Brunner, cherry-crimson

POLYANTHA (DWARF HEDGE ROSE)

Katherine Zeimet (white baby rambler)
Clotilde Soupert, flesh
Orleans, geranium-red (the best ever-blooming variety for hedges yet found)

RUGOSA, OR JAPAN ROSE

Any variety that is suitable (the single or semi-double only produce the scarlet hips or seed pods)

SWEETBRIER

Any Lord Penzance variety that is suitable (do well in partial shade and shrubbery borders)

MOSS ROSES

Any variety that is suitable

WICHURAIANA AND CLIMBERS

Hiawatha, brilliant scarlet
La Fiamma, crimson and white
Dorothy Perkins, light pink
Dorothy Perkins, white
American Pillar, pink with a clear white eye
Lady Gay, cherry-pink

Spring and Summer Care.—Before growth commences in the spring, the surplus coarse manure should be removed from the beds and the remaining fine portion turned under. Deep cultivation is not desirable—three inches being quite sufficient in beds which have not been trampled on—as the roots are likely to be injured or broken. For this purpose it is desirable to use a four-pronged digging fork, as it is less likely to injure the roots than a spade. Afterwards, and until the buds begin to develop, nothing more is necessary

except frequent stirring of the surface with a sharp-pointed rake. As the flowering season approaches, feeding with liquid cow manure should begin and should continue until the blooming season is over, after which all stimulation should cease. The liquid cow manure is conveniently prepared by adding about six pails of fresh cow manure to a barrel of water (fifty gallons) and allowing the mixture to stand a day or two before using. If a half bushel of soot contained in a burlap bag is hung over night in the barrel of liquid manure, the beneficial properties of the fertilizer will be greatly increased. About one-half gallon of this infusion should be used for each plant and the application may be repeated once a week. It is safe to say that this is one of the most efficient fertilizers for roses, and its continued and careful use is partially responsible for the splendid showing made by the roses in the Garden. During July a light top dressing of finely crushed bone is also of advantage.

Although it is generally believed that magnesium in excess is the most poisonous of all the plant nutrients or fertilizers, Tonk, as early as 1889, recommended a manure for roses containing sulphate of magnesium with, however, an excess of lime. Here the matter rested for twenty years. In 1909, Truffant noted the large proportion of magnesium found in the analysis of roses, and stated that soils deficient in this element produced but a weak growth of roses, but that the addition of magnesium salts brought about a marked increase of vigor and growth. The following year at the International Rose Conference, in Paris, the particular value of magnesium for roses was one of the subjects for discussion. It was declared to be indispensable and it was stated that it should always be given in the form of sulphate in doses of about five ounces to the square yard.

As the result of recent experiments at the Garden, and the experience of at least one practical rose grower of national reputation, it is believed that the following practice is correct: Attention should be called to the fact that all roses do not react alike, and some varieties not yet tested may not respond satisfactorily or may even be slightly injured by the magnesium. One should, therefore, proceed cautiously. If plants are to be watered with a solution, use nitrate of magnesium at the rate of one ounce to the gallon. This may be used once a week through the season, but if any ill effects are noted, the application should be discontinued. If the magnesium is to be applied dry, it is better to use finely powdered commercial carbonate of magnesium which contains a certain amount of lime.

This should be applied at the rate of one-third of a pound to the square yard. No immediate effect will be noticed from the application, but, later, increased sturdiness and consequent richness of foliage and blossom should result.

Insects.—Half starved and otherwise neglected roses are quite susceptible to insect attacks, which, however, is not the case if the plants are properly cared for. In St. Louis and vicinity the most serious insect enemy of the rose is probably the green fly, well known to all who have grown roses. It is a small, green plant-louse, or aphid, about one-eighth of an inch in length when full-grown and usually wingless. The body is oval and soft and secretes a sweet fluid of which ants are particularly fond. The presence of ants on rose bushes is good evidence that the aphids are at work. The latter usually work on the young shoots, sucking the juices with their long, slender beaks, and if unmolested quickly destroy the vigor and vitality of the rose plant. The most effective agent with which to combat the aphid is tobacco smoke, but its use out of doors is obviously connected with serious difficulties. In its place, however, a solution made from tobacco stems and whale-oil soap will be found effective. To make this solution one pound of tobacco stems should be soaked in a gallon of water over night, after which one ounce of whale-oil soap, which has first been dissolved in a small quantity of hot water, should be added (it will require three or four hours for the soap to thoroughly dissolve). The solution so prepared should be thoroughly stirred before using and may be applied either with a sprayer or with a whisk broom. This quantity is sufficient for about twenty-five plants. Where a sufficient water pressure is available the green fly may further be kept in check by vigorously spraying the plants from time to time, as required.

Another troublesome pest of out-door roses is the rose hopper, or thrips. This insect is small, yellowish white, about three-twentieths of an inch long, and provided with a pair of transparent wings. It preys upon the leaves, working especially on the under side, causing the foliage to assume a sickly yellowish appearance. The control of this insect is more difficult because of its active jumping and flying habits. Spraying the plants with water, so as to wet the under side of the leaves, and subsequently dusting them with powdered hellebore usually effects a sufficient control.

Several kinds of caterpillars prey upon the rose, sometimes causing considerable injury. All of them envelop themselves in the leaves or burrow in the flower buds. Powdered hellebore sprinkled over the plants prevents to a

considerable extent the movements of the larvae, but removal is best accomplished by actually picking them from the plants.

Fungous Diseases.—The mildew is perhaps the commonest disease of the rose in this locality. Some varieties are seldom attacked and certain locations are much more subject to it than others. The disease generally makes its appearance in the autumn, when the nights begin to grow cool. At this season, however, it works but little harm, as the plants have made their growth and the wood is nearly or quite ripened. A mixture of equal parts of quick lime and sulphur, applied when the dew is on the plants, will usually prevent mildew. At the Garden the following solution has been used successfully: one ounce of copper carbonate, one pint of ammonia, and ten gallons of water. Plants should be sprayed with this mixture once a week, using a nozzle giving a fine spray.

Winter Protection.—The work of protecting roses against the severe cold of the winter should be done by November 20. The earth should be heaped up around each plant to a depth of from two to three inches in order to provide drainage away from the center of the plant, and from four to six inches of straw manure should be placed over the entire surface of the bed. This treatment will protect any of the varieties previously mentioned, except the tree, or standard roses. These are budded at the crown and unless wrapped with hay or straw, freeze very easily.

Pruning.—One of the most important considerations in rose culture is that of pruning. No directions can be given which will be sufficiently explicit to enable one to know just what to do in each individual case; practical experience alone can furnish this information. But the general principles that should be observed in pruning can be readily stated. As regards tools, a pair of good shears and a pruning knife with hooked blade are desirable. The work can be more quickly and easily done with the former, but where a very smooth cut is to be made, the pruning knife is preferable—also because it is less likely to bruise the bark.

All pruning should be done while the plants are dormant. The chief objects to be held in view in pruning roses are: the production of a symmetrical plant, and the promotion of flower bud formation. To secure these results plants of delicate habit and weak growth should be severely pruned. Vigorous growers, on the other hand, should have the shoots only moderately shortened, but the branches well thinned out. In all cases the cut should be straight across the stem

in order to expose a minimum amount of wounded surface, and care should be taken that the top bud which remains points outward. Climbing roses require no pruning beyond cutting out the very old and dead wood and shortening the laterals, except the trimming which may be necessary to make the plants conform in shape to a particular arbor or trellis. The tendency around St. Louis seems to have been towards over pruning.

The varieties at present growing in the rose garden are given in the following two lists. In the first one the varieties are listed in alphabetical order, each followed by a number indicating position in the accompanying plan; and in the second the arrangement is a numerical one according to the numbers given in the first list.

ALPHABETICAL LIST OF VARIETIES IN ROSE GARDEN

Alfred K. Williams, 125
American Beauty (climber), 20
American Pillar, 19
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Anne of Geierstein, 57
Antoine Rivoire, 26
Augustine Guinoisseau, 77
Augustine Guinoisseau (standard), 48
Baby Rambler, 89
Barbarossa, 115
Baron Rothschild, 112
Beauté de Lyon, 63
Betty, 30
Blanche Moreau, 127
Blumenschmidt, 68
Captain Hayward, 70
Cecile Brunner, 14
Clio, 123
Clotilde Soupert, 4
Colonel le Clerc, 129
Conrad F. Meyer, 109
Coronation, 21
Countess of Gosford, 87
Crimson Rambler, 147
Daybreak, 8
Dean Hale, 102
Debutante, 17
Dorothy Perkins, 146
Dr. O'Donel Browne, 116
Dr. W. Van Fleet, 3
Duchess d'Assuna, 118
Duchess of Albany, 106
Duchess of Wellington, 33
Duke of Edinburgh, 132
Duke of Teck, 141
Earl of Dufferin, 131
Ecarlate, 69
Edu. Meyer, 65
Entente Cordiale, 111
Ethel Malcolm, 104
Etoile de France, 81
Excelsa, 37
Farben Königin, 154
Farquhar Rose, 6
Flower of Fairfield, 41
Francisca Kruger, 107
Frau Karl Druschki, 9, 51
Garten Director Hartrath, 126
General Jacqueminot, 130
General McArthur, 43
George C. Waud, 149
Gruss an Teplitz, 50
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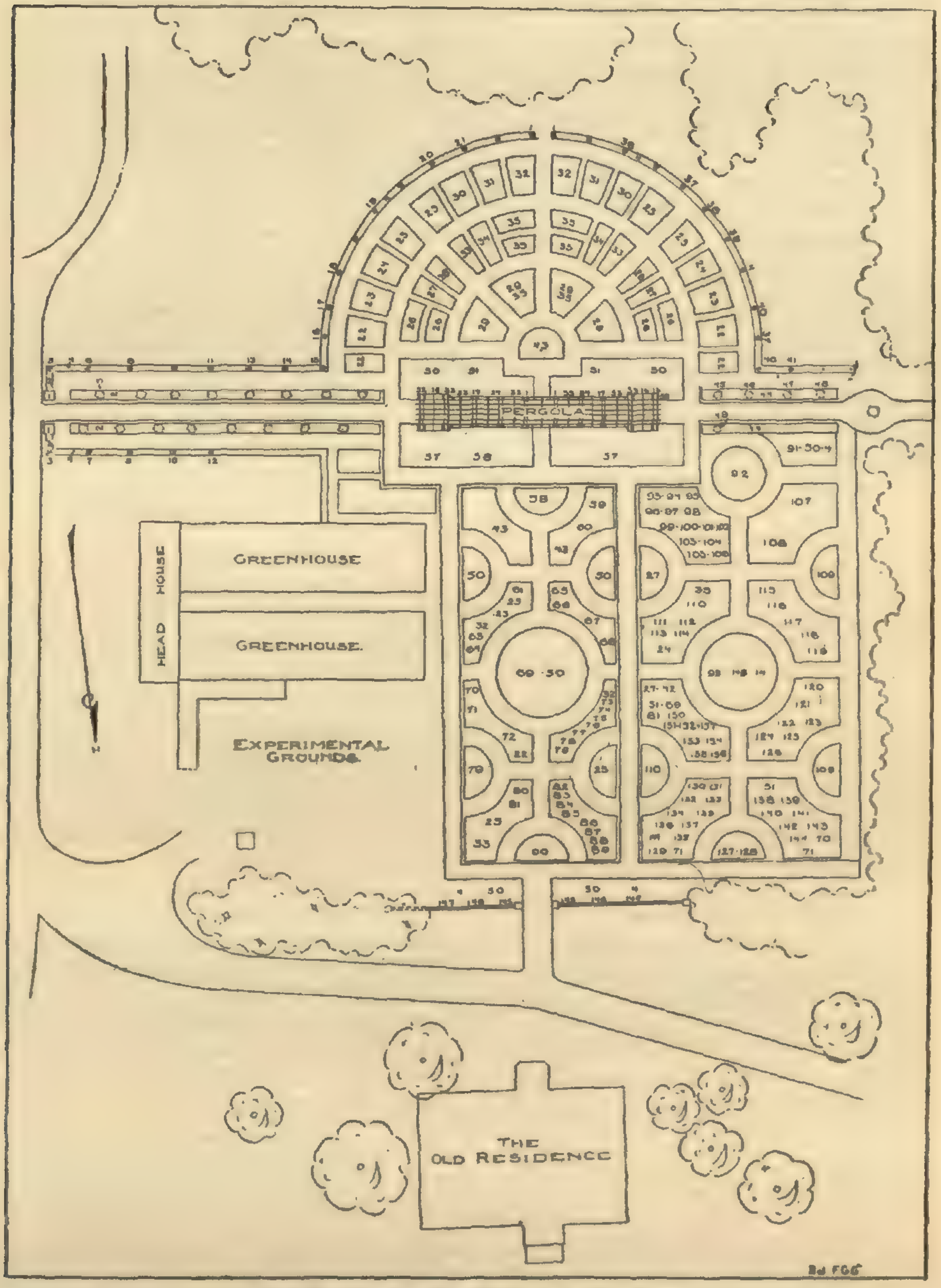
Gruss an Teplitz (standard), 46
Gustave Grunerwald, 75
Gustave Regis, 62
Harry Kirk, 28
Helen Gould, 60
Hermosa, 108
Hiawatha, 55
His Majesty, 119
Hugh Dickson, 142
Indiana, 86
Irish Fireflame, 95
J. B. Clarke, 71
Jonkheer J. L. Mock, 23
Kaiserin Augusta Victoria, 83
Kaiser Friederich, 124
Kalmia, 52
Katherine Zeimet, 44
Killarney, pink, 58
Killarney, white, 35, 85
La Detroit, 59
La Detroit (standard), 49
La France, 25

La France (standard), 45
La Fiamma, 1
La Progress, 113
La Reine, 133
La Tosca, 136
Lady Alice Stanley, 24
Lady Ashtown, 27
Lady Ashtown (standard), 47
Lady Gay, 16
Lady Gay (standard), 5
Lady Helen Stewart, 144
Lady Ursula, 150
Laurente Carle, 29
Leonie Lamesch, 99
Liberty, 90
Magna Charta, 155
Maid Marion, 56
Maman Cochet, 82
Margaret Dickson, 138
Marie Van Houtte, 66
Marshall Field, 84
May Queen, 40
Mad. Caroline Testout, 42
Mad. Charles Wood, 92
Mad. Edmond Sablayrolles, 137
Mad. Gabriel Luizet, 140
Mad. Isaac Pereire, 117
Mad. Jules Grolez, 79
Mad. Leon Constantine, 76
Mad. Leon Paine, 34
Mad. Ravary, 32
Meg Merrilies, 58
Meteor, 11
Milady, 97
Mildred Grant, 72
Minnehaha, 38, 54
Miss Cynthia Forde, 22
Miss Nosman, 103
Mme. Edouard Herriot, 94
Mme. Eugene Marlatt, 101
Mme. Maurice Luze, 78
Mme. Melanie Soupert, 156
Mrs. Aaron Ward, 80
Mrs. Andrew Carnegie, 93
Mrs. A. R. Waddell, 153
Mrs. George Shawyer, 100
Mrs. Herbert Stevens, 98
Mrs. James Gray, 74
Mrs. M. H. Walsh, 15
Mrs. John Laing, 134
Mrs. R. G. Sharman-Crawford, 139
Mrs. W. G. Miller, 151
Natalie Bottner, 152
Orleans, 2
Otto von Bismarck, 110
Paradise, 53
Perle von Godesberg, 61
Philadelphia, 10
Philemon Cochet, 121
Princesse Adelaide, 128
Radiance, 105
Reine Marguerite d'Italie, 148
Rodhatte, 64
Ruhm der Gartenwelt, 135
Safrano, 67
Shower of Gold, 39
Souv. de la Malmaison, 88
Souv. de Pres. Carnot, 31
Souv. de Wootton, 36
Sweetheart, 7
Tausendschön, 145
Tom Wood, 120
Trier, 12
Ulrich Brunner, 143
Viridiflora, 91
Viscountess of Folkestone, 157
William R. Smith, 73
Willowmere, 96
Yellow Rambler, 13
Zephyrine Drouhin, 122

NUMERICAL LIST OF VARIETIES IN ROSE GARDEN

1. La Fiamma
2. Orleans
3. Dr. W. Van Fleet
4. Clotilde Soupert
5. Lady Gay (standard)
6. Farquhar Rose
7. Sweetheart
8. Daybreak
9. Frau Karl Druschki
10. Philadelphia
11. Meteor
12. Trier
13. Yellow Rambler
14. Cecile Brunner
15. Mrs. M. H. Walsh
16. Lady Gay
17. Debutante
18. Gruss an Teplitz (climber)
19. American Pillar
20. American Beauty (climber)
21. Coronation
22. Miss Cynthia Forde
23. Jonkheer J. L. Mock
24. Lady Alice Stanley
25. La France
26. Antoine Rivoire
27. Lady Ashtown
28. Harry Kirk
29. Laurente Carle
30. Betty
31. Souv. de Pres. Carnot
32. Mad. Ravary

33. Duchess of Wellington
34. Mad. Leon Paine
35. Killarney, white
36. Souv. de Wootton
37. Excelsa
38. Minnehaha
39. Shower of Gold
40. May Queen
41. Flower of Fairfield
42. Mad. Caroline Testout
43. General McArthur
44. Katherine Zeimet
45. La France (standard)
46. Gruss an Teplitz (standard)
47. Lady Ashtown (standard)
48. Augustine Guinoisseau (standard)
49. La Detroit (standard)



PLAN OF THE ROSE GARDEN

(The numbers refer to the varieties in the accompanying lists)

50. Gruss an Teplitz
51. Frau Karl Druschki
52. Kalmia
53. Paradise
54. Minnehaha
55. Hiawatha
56. Maid Marion
57. Anne of Geierstein
58. Meg Merrilies
58. Killarney, pink
59. La Detroit
60. Helen Gould
61. Perle von Godesberg
62. Gustave Regis
63. Beauté de Lyon
64. Rodhatte
65. Edu. Meyer
66. Marie Van Houtte
67. Safrano
68. Blumenschmidt
69. Ecarlate
70. Captain Hayward
71. J. B. Clarke
72. Mildred Grant
73. William R. Smith
74. Mrs. James Gray
75. Gustave Grunerwald
76. Mad. Leon Constantine
77. Augustine Guinoisseau
78. Mme. Maurice Luze
79. Mme. Jules Grolez
80. Mrs. Aaron Ward
81. Etoile de France
82. Maman Cochet
83. Kaiserin Augusta Victoria
84. Marshall Field
85. Killarney, white
86. Indiana
87. Countess of Gosford
88. Souv. de la Malmaison
89. Baby Rambler
90. Liberty
91. Viridiflora
92. Mad. Charles Wood
93. Mrs. Andrew Carnegie
94. Mme. Edouard Herriot
95. Irish Fireflame
96. Willowmere
97. Milady
98. Mrs. Herbert Stevens
99. Leonie Lamesch
100. Mrs. George Shawyer
101. Mme. Eugene Marlatt
102. Dean Hale
103. Miss Nosman
104. Ethel Malcolm
105. Radiance
106. Duchess of Albany
107. Francisca Kruger
108. Hermosa
109. Conrad F. Meyer
110. Otto von Bismarck
111. Entente Cordiale
112. Baron Rothschild
113. La Progress
114. Anna de Diesbach
115. Barbarossa
116. Dr. O'Donel Browne
117. Mad. Isaac Pereire
118. Duchess d'Assuna
119. His Majesty
120. Tom Wood
121. Philemon Cochet
122. Zephyrine Drouhin
123. Clio
124. Kaiser Friederich
125. Alfred K. Williams
126. Garten Director Hartrath
127. Blanche Moreau
128. Princesse Adelaide
129. Colonel le Clerc
120. General Jacqueminot
131. Earl of Dufferin
132. Duke of Edinburgh
133. La Reine
134. Mrs. John Laing
135. Ruhm der Gartenwelt
136. La Tosca
137. Mad. Edmond Sablayrolles
138. Margaret Dickson
139. Mrs. R. G. Sharman-Crawford
140. Mad. Gabriel Luizet
141. Duke of Teck
142. Hugh Dickson
143. Ulrich Brunner
144. Lady Helen Stewart
145. Tausendschön
146. Dorothy Perkins
147. Crimson Rambler
148. Reine Marguerite d'Italie
149. George C. Waud
150. Lady Ursula
151. Mrs. W. G. Miller
152. Natalie Bottner
153. Mrs. A. R. Waddell
154. Farben Königin
155. Magna Charta
156. Mme. Melanie Soupert
157. Viscountess of Folkestone

NOTES

Recent visitors to the Garden include Miss Gladys Earle, Teacher of Botany at Ward-Belmont College in Nashville,

Tennessee, and Miss Nora E. Dalbey, Assistant in Botany at the University of Illinois.

About fifty delegates to the Pan-American Financial Conference, accompanied by a number of members of the Business Men's League of St. Louis, visited the Garden on Saturday afternoon, June 5.

Dr. J. R. Schramm, for three years Assistant to the Director of the Missouri Botanical Garden, has been appointed Assistant Professor of Botany in Cornell University, and will enter upon his new duties on July 1.

Delegates from eastern and southern cities, with their friends, on their way to attend the National Association of Real Estate Exchanges, were interested visitors at the Garden on July 16. The party numbered about 150 persons.

Of the Rufus J. Lackland Research Fellows who have been studying during 1914–15 in the Graduate Laboratory, Mr. W. W. Bonns and Mr. R. A. Studhalter will spend the summer at the University of Chicago in the Department of Chemistry; Mr. G. W. Freiburg will study French at the University of Washington and will spend some time collecting study material; and Mr. S. M. Zeller will continue his investigations in St. Louis.

Members of the Graduate Laboratory, 1914–15, who have received appointments from other institutions are as follows: Dr. M. C. Merrill, Director of the Department of Agriculture, Idaho Technical Institute, Pocatello, Idaho; Dr. W. H. Emig, Instructor in Botany, Oklahoma Agricultural College, Norman, Oklahoma; Dr. J. C. Gilman, Professor of Biology, Ripon College, Ripon, Wisconsin; Dr. L. O. Overholts, Instructor in Botany, Pennsylvania State College, State College, Pennsylvania; and Mr. F. B. Wann, Instructor in Botany, Cornell University, Ithaca, New York.

The degree of Doctor of Philosophy was conferred by Washington University, June 10, 1915, on M. C. Merrill, Research Assistant, with a thesis on "Electrolytic determination of exosmosis from the roots of plants subjected to the action of various agents"; and on the following Lackland Research Fellows: A. R. Davis, "Enzyme action in marine algae"; W. H. Emig, "The occurrence in nature of certain yeast-like fungi with relation to their possible pathogenicity in the higher animals"; J. C. Gilman, "Cabbage yellows and the relation of temperature to its occurrence"; and L. O. Overholts, "Comparative studies in the Polyporaceae." The degree of Master of Arts was conferred on Miss Mary M. Bryan, with a thesis on "A spurless variety of *Habenaria psychodes*."

STATISTICAL INFORMATION FOR MAY, 1915

GARDEN ATTENDANCE:

Total number of visitors	22,987

PLANT ACCESSIONS:

Total number of plants received in exchange	46
Total number of seed packets received in exchange	66
Plants donated	9

LIBRARY ACCESSIONS:

Total number of books bought	47
Total number of books and pamphlets donated	93

HERBARIUM ACCESSIONS:

By Purchase —

G. W. Freiburg—Plants of Minnesota	215
Th. Holm—Plants of Porto Rico	156
H. Sydow—"Fungi exotici exsiccati" Fasc. VII, VIII, IX, Nos. 301–450	150

By Gift —

E. Bartholomew—*Hypoxylon atropunctatum* from Kansas	1
Botanic Garden of Pisa—Lichens and fungi of Italy	52
A. Davidson—*Calochortus discolor* Davidson from California	1
J. A. Drushel—Plants of Ohio and Missouri	11
B. E. Evans—*Septobasidium pedicellatum* on orange twigs and leaves from Florida	1
J. H. Faull—Fungi from Canada	94
F. Grossart—*Rhododendron nudiflorum* (L.) Torr. from Missouri	1
A. L. Kammerer—Plants of New Mexico	245
E. O. Matthews—Specimens of fungi from Mexico	4
P. A. Kohl—*Orobanche uniflora* L. from Missouri	1
Amy M. Pier—*Thelephora terrestris* from Maine	1
Miss Alice Thompson—*Trillium declinatum* (Gray) Gleason from Missouri	1
J. R. Wier—*Thelelphora fimbriata* incrusting seedlings of *Pinus ponderosa*	1
Mrs. F. L. Young—*Rhododendron nudiflorum* (L.) Torr. from Missouri	1
TOTAL	936

The Garden is open to the public week days the year 'round from 8:00 A. M. until one-half hour after sunset. Until November 30, the Garden will be open Sundays from 2:00 P. M. until sunset. Admission free.

Personally conducted trips through the Garden every Saturday afternoon from May 1 to November 1, starting from the main gate at 3 o'clock. Other trips may be arranged for by special appointment.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

☛ **The Garden will be open from 2:00 P. M. until sunset, Sunday, July 4, but closed all day Monday, July 5.**

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G. H. PRING,
Orchids and other Exotics.

P. FOERSTER,
Farm and Stables.

M. SCHILLER,
New Conservatories.

K. N. SVETLIKOFF,
Plant Breeding and Seeds.

MISSOURI BOTANICAL GARDEN BULLETIN

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1915

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Missouri Botanical Garden Bulletin

Vol. III St. Louis, Mo., July, 1915 No. 7

CANNAS

Cannas are of tropical origin and are indigenous to South America, Central America, and the West Indies, and at least one species (*Canna flaccida*) is native to Florida. As early as 1848 cannas had made their appearance in Europe and were grown for their foliage or mass effect. At that time the plants were tall and long-jointed with small flowers coming at the end of the season. There being many objections to these tall, weed-like cannas an attempt has been made since their introduction to increase the size of the flowers, the range of color in both flowers and foliage, and to decrease the height of the plant. Reference to the collection of cannas shown this year at the Garden will give a comprehensive idea of the success of this undertaking. Hybridization has produced decrease in stature and larger flowers, and a survey of the progress of the hybrids leads one to believe that large flowers and dwarf plants are coincident. The plants do not wait for their full growth before starting to bloom, however. A six-foot canna will probably send out its first flowers when it is not over a foot high, but these flowers will very likely be poor specimens. It is not until the plants have become firmly established, about the first of August, that they will attain their maximum as to size, form, and color of blossom.

The first important production of the hybridizer was the so-called French or Crozy canna originated by M. Crozy, of France. The crossing of our native variety (*Canna flaccida*) with the iris-flowered canna was accomplished by Dammann of Italy, and the hybrid is known as the orchid-flowered canna, and also as the Italian canna. The flower has the form of the iris but is rather short-lived. "Italia," "Austria," and "America" are the best-known varieties of this type. While the Italian cannas undoubtedly have the largest flowers, their late blooming qualities and the frailness of the blooms have been objectionable, and later varieties such as "New York," "Louisiana," and "King Humbert" are

improvements. The latter is especially noteworthy on account of its large leaves and is probably the best all-round variety yet grown.

Color.—Red, yellow, and red and yellow spotted were the characteristic colors of the early cannas, the flowers being produced in a terminal raceme or panicle. To-day, owing to the work of the plant breeder, we have a wide range of color, including maroon, crimson, scarlet, yellow, and rich orange, and last, though perhaps best of all, the pure white. The color of the flower is best appreciated when viewed against a background of green, and, in a formal arrangement, the canna groups should be so placed as to obtain a background of shrubbery or trees. An informal planting is more difficult, but excellent effects may be secured by scattering the plants singly or in very small clumps in the hardy border or in shrubbery.

Culture.—Cannas require a rich, friable, moist, and warm soil. Good corn weather is also good canna weather and nothing is gained by planting out cannas too early in the season. The beds for cannas should be well prepared. It must be remembered that cannas make a tremendous growth during the season and therefore require plenty of food and a good depth of soil in which the roots may feed. A wheelbarrow of good well-rotted stable manure to the square yard of soil is not too much for new canna beds, although if the same bed is used another year, a smaller amount is sufficient.

It is possible to either plant the dormant roots directly in the beds outside or to start the plants inside under glass. When planting the dormant roots directly in the beds, care must be taken that the eyes or growing points are not placed too deep—one inch deep being sufficient. Plants that have been started in pots may be planted slightly deeper in the beds. Where mass or hedge effect is desired, the plants may be set 12 inches apart, but where the beauty of the individual specimen is the ideal, three feet is not too much. In general, it may be better to plant not closer than 18 inches and to give orchid-flowering varieties even more room.

During the summer water must be supplied abundantly and a lookout kept for any insects that may attack the leaves. Owing to the nature of the canna leaves, spraying materials do not stick well, so when caterpillars or other insects attack the plant they should be picked off by hand and destroyed. Picking off dead leaves and flowers are matters of routine that make any bed of flowers more attractive. In the fall the canna plants may be dug up and transplanted

into tubs in the house where they will continue to bloom for some time. When the flower stalk has furnished its last flower, it should be cut off close to the roots so that the strength of the roots may be sent into the new stalks. A careful survey of the stalk will show when the last flower branch has been sent forth.

Winter Storage.—Cannas should be left out in the fall until the frost has destroyed all of the foliage. It is desirable to let the foliage hang on and dry for a few days after the first heavy frost; then the tops should be cut off and the plants marked with wooden labels stating the name of the variety or at least the height and color. The clumps can then be dug up and placed in any pit or cellar where potatoes or other root crops would keep well. Too much heat or dampness should be avoided.

It is not necessary to remove all of the soil from the roots when they are dug up. The presence of a little soil will make the process of ripening much more natural and will keep the roots from drying out too much. During the late winter or early spring the soil and all excess leaves should be removed from the roots and then if desired they can be subdivided, care being taken that each section includes one good strong eye or growing point. Root cuttings of this sort are usually started in the greenhouse in sand and when new roots have started are potted in good soil. This is the better way to plant cannas as they are then able to get a good start before being planted in the outside beds.

To sum up: cannas require a rich soil and an abundance of water, and it must always be remembered that they are a tropical plant and must not be planted outside until the weather is warm. Observance of these few and simple rules should make canna culture easy for anyone.

The following ninety-two varieties of cannas will be found at the entrance of the Economic Garden. All the plants have green foliage except as noted. The figures indicate the approximate height of the plant. The collection was supplied and arranged by Mr. L. D. Yager of Alton, Illinois:

ALLEMANIA.—The standard light red and yellow orchid type. The flowers are very large, and in size and texture resemble the flowers of the Wyoming. 6 feet.

AUSTRIA.—The common yellow orchid type; the standard of its class in all gardens. 6 feet.

BERTHINE BRUNNER.—Good yellow; long, narrow petals, lightly dotted with red. 5 feet.

BLACK PRINCE.—Velvety maroon. 5 feet.

BRANDYWINE.—Vinous red, dappled crimson, occasionally edged yellow. 3 feet.

BRILLIANT.—A bright lemon-yellow, in some respects better than Buttercup; lower petal divided to give the appearance of two red tongues. 4 feet.

BUTTERCUP.—As the name implies, it is a buttercup yellow. Fair sized flower and good bloomer. 3 feet.

CINNABAR.—Of a cinnamon-red shade. Flowers not very large but odd. 4 feet.

CLOTH OF GOLD.—Pure orange, tinted gold and coppery red. Bronze foliage. 4 feet.

COMPTE DE BOUCHARD.—The highest type of the Florence Vaughan style of canna. Flowers, the largest of all red and yellow spotted varieties. Trusses immensely. 4 feet.

COUSIN MATHIEU.—Deep red. Petals show a bronzy effect when held in the sunlight. 4 feet.

DAYBREAK.—Flesh-white in color; outer part of petals pure white, throat of flower carmine; petals, four of equal size, standing out fully expanded. Trusses beautifully and holds up under the hottest sun for several days, notwithstanding its exceedingly delicate texture. One of the finest cannas. 4 feet. Originated by L. D. Yager.

DEFENDER.—Clear, rich yellow, striped scarlet. 3½ feet.

DAVID HARUM.— Vermillion scarlet, mottled deep red. Bronze foliage. 4 feet.

DR. CAVET.—One of the finest tall, red cannas; color, a deep cardinal with just a touch of yellow in the throat. 6 feet.

DUKE OF MARLBORO.—Deep crimson; one of the darkest reds. 3 feet.

EASTERN BEAUTY.—Light salmon and orange. Bronze foliage. 4 feet.

EVOLUTION.—Flowers fair sized but of odd coloring, shading from creamy white to pale buff. Bronze foliage. 4 feet.

FLORENCE VAUGHAN.—The old standard red and yellow spotted canna. 4 feet.

FLORIDA.—Scarlet with yellow band. 3 feet.

FRAU MARIE NAGEL.—Long petals of a soft lemon-yellow, turning to almost pure white after a few hours in the sun. Classed as a white canna. 3 feet.

FREDERICK BENARY.—A bold and striking flower of a very large size. Orchid type but petals are firm and stand out strong; color, a pale orange and light red. Resembles Allemania somewhat, but much better flower though not so large. 6 feet.

GLADIATOR.—The brightest of all red and yellow spotted cannas. Flower has bright red tongue which adds to its beauty. 6 feet.

GLADIOFLORA.—Gladiolus shaped; crimson changing to carmine rose, edged unevenly with gold. 3½ feet.

GLORIOSA.—Fiery red and yellow marbled. A most dazzling canna. 3 feet.

GOV. ROOSEVELT.—Flowers usually red but have the peculiarity of "showing a yellow streak"; some flowers red, some yellow and some both colors. 3 feet.

GUSTAV GUMPPER.—A recent introduction from Holland. Flowers a deep orange-yellow—a most peculiar shade and one long missing. Fine bloomer. 4 feet.

HALLEY'S COMET.—One of the recent novelties. Large flowers; colors, bright red and gold. 4 feet.

HIAWATHA.—Delicate rosy pink with border of cerise. Bronze foliage. 4 feet.

HOHENZOLLERN.—Canary-yellow. A recent introduction. 5 feet.

HUNGARIA.—A bright pink somewhat on the order of Venus, but lacking the marbling of the latter. The center of the flower shows a pure white in the calyx. Perhaps the daintiest of all cannas. 4 feet.

INDIANA.—Flower golden bronze, the color of Wyoming, but smaller, and petals are stiff. 6 feet.

ITALIA.—Bright red and yellow orchid-flowered. Not so large as Allemania but colors much brighter. 6 feet.

J. D. EISELE.—A small flower, brilliant red in color, some flowers showing light streaks of yellow. Trusses well and makes a fine show. 5 feet.

J. H. YAGER.—A ruby-colored flower, having bands and dots of creamy yellow variously placed on the petals. Excellent trusser and very fine show plant. Light bronze foliage. 5–6 feet. Originated by L. D. Yager.

JOHANNA KANSLEITER.—Large, pale yellow flowers. An extra fine canna. 5 feet.

KATE GRAY.—Deep orange, shaded carmine; yellow throat. 6 feet.

KING HUMBERT.—The canna that took first prize at the Buffalo Exposition in 1900. Exploited in all catalogues as the best all-round canna. A large orchid-flowered type; red with streaks of various shades. Fine bronze foliage. 4 feet.

LEONARD PATRY.—Coral-pink, with gold border on petals. 5 feet.

LEOPARD.—Cream and pink spotted. 3½ feet.

LONG BRANCH.—Yellow and gold marbled; orchid-flowered. 5 feet.

LORRAINE (IMP.).—Light pink with cream-colored spots and blotches. 5 feet.

LOUISE.—Rose-pink dappled with red. 5 feet.

LOUISIANA.—Deep red, orchid-flowered. Large flower. Canna that took first prize at the Louisiana Purchase Exposition, whence the name. 6 feet.

LUCY P. FRANCIS.—A bright pink with lighter streaks in the petals. Has the novelty of re-curved petals. 5 feet. Originated by L. D. Yager.

LURAY.—A beautiful, soft shade of pink. For many years considered the best pink, and only displaced by Mrs. Alfred Conard and Maiden's Blush. 3 feet.

MAD. CELESTINE DUBOST.—Very much like Lorraine, but the petals are longer and the color is deeper. 5 feet.

MAD. CROZY.—The old original red and yellow marbled. The first big stride in the red and yellow variety; still a stand-by. 3 feet.

MADISON.—Creamy white, with faint pink dots near the calyx. One of the best to withstand the sun. Very profuse bloomer. 6 feet. Originated by L. D. Yager.

M'LLE. BERAT.—Long, wavy, widely expanded petals of dark pink. Another fine show canna. 4 feet.

M'LLE. COMBET.—A most peculiar shade, resembling a ripe apricot; streaked with deeper shadings. Flowers large and petals hang loose. One of the oddest and most striking cannas. 5 feet.

MAIDEN'S BLUSH.—Pale pink flowers of fine quality. Sturdy plant with fine musa-like foliage. 3 feet.

MAJESTIC.—Deep red, with edge of gold. 4 feet. Originated by L. D. Yager.

MAROS.—Dreer's white. A beautiful canna, and very profuse. 4 feet.

MEPHISTO.—A very deep red, one of the darkest shades known in red cannas. Fine. 5 feet.

METEOR.—Bright red and fine flower. 3 feet.

MINNEHAHA.—A good-sized flower having loose petals; color, almost white with darker edging. 3 feet.

MT. BLANC (IMP.).—To date the best white canna known. Petals almost pure white and of fair size. 3 feet.

MRS. ALFRED CONARD.—A recent novelty. Large pink flowers of fine shade and quality; one of the best pinks. 4 feet.

MRS. E. M. GADDIS.—New. Color, bright red and orange variegated. Flower of good size and gladiolus-shaped; profuse bloomer. 4 feet. Originated by L. D. Yager.

MRS. GEORGE STROHLEIN.—An Oriental-red canna of fine texture. Fine trusser and one of the best "show" reds. Bronze foliage. 5 feet.

MRS. KARL KELSEY.—Bright red and yellow marbled. Belongs to the orchid type and resembles Long Branch. A large and brilliant flower. 6 feet.

MRS. KATE F. DEEMER.—A recent novelty. Flowers in large trusses; color, a light yellow, turning to a pinkish shade the second day. One of the very good cannas. 5 feet.

NIAGARA.—Very much like Gloriosa, but smaller flower of lighter shades, and taller plant. 4 feet.

OLYMPIC.—An ordinary red canna of profuse habit. 5 feet.

PAPA NARDY.—A peculiar shade of red. Petals very large and round with streaks of darker shades. A good show canna. 4 feet.

PENNSYLVANIA.—The standard red in the orchid-flowered type. 6 feet.

PILLAR OF FIRE.—A giant in height. Bright crimson. 7 feet.

QUEEN CHARLOTTE.—Orange and gold. An old stand-by. 3 feet.

QUEEN OF HOLLAND.—Peculiar shade of deep yellow. Bronze foliage. 3 feet.

RICHARD WALLACE.—Pale yellow, with long petals. Fine plant. 4 feet.

ROSEA GIGANTEA.—Soft rose to wine colored. Very large flowers. 4 feet.

ROSEMAWR.—Pink with throat of gold. Large flowered. 3 feet.

SAFFRON KING.—A saffron-yellow shade; profuse bloomer. 4 feet.

SEMAPHORE.—A most peculiar shade, resembling the color of the inside of an old-fashioned Connecticut field pumpkin. Bronze foliage. 4 feet.

SHENANDOAH.—A soft pink. The only pink canna with bronze foliage. 3 feet.

SOUV. D'ANTOINE CROZY.—Intense scarlet with golden yellow border. 3 feet.

STRIPED BEAUTY.—Whitish-yellow with ruby throat. Makes a fine show plant. 4 feet.

UHLBERG.—Novelty. Rosy carmine with yellow throat. 3 feet.

VENUS.—A gay, rosy pink marbled with creamy white. Four petals stand out bold, arranged like the four leaved clover. A most beautiful flower. 5 feet.

WAWA.—Creamy white to flesh color with gilt stripe bordering the edge of petals. Flower not very large, but clusters well, making a beautiful display canna. 3 feet.

WEST GROVE.—Coral colored. 4½ feet.

WM. BECK.—Colors similar to Italia, but the flower is gladiolus shaped, making a half-orchid type. The only one of its kind. 5 feet.

WM. SAUNDERS.—The best of all low-growing cannas. Flowers very bright and large, with a whitish cast in the throat. Bronze foliage. 3 feet.

WM. TRELEASE.—Bright red and rather cup-shaped flower. Individual flower unimportant, but the extreme profuseness of stalks and flowers make this variety an exceedingly fine bedder. 4 feet. Originated by L. D. Yager.

WINTZER'S COLOSSAL.—Claimed to be the finest of the orchid type. Vivid, scarlet flowers measuring 8 inches across. 5 feet.

WINTZER'S METEOR.—A vast improvement on the original and flowers much larger. 4 feet.

WYOMING.—Flower a golden bronze; very large orchid type. The fluffy petals wave and flap in the wind. The finest bronze foliage with fine flowers. 6 feet.

YELLOWHAMMER.—Yellow with red spots; profuse bloomer. Between Florence Vaughan and Berthine Brunner. 5 feet. Originated by L. D. Yager.

ZENITH.—A soft pink, veined with a darker shade. Exceedingly large cup-shaped flower. A beauty. 5 feet.

WATER GARDENS

The water-lilies at the Missouri Botanical Garden are being grown this summer chiefly in two gardens. The larger containing various hybrids of both day and night-blooming nymphaeas is situated midway between the main gate and the conservatories, greeting the visitor as soon as he enters the Garden. The smaller is immediately in front of the Linnean House and is known as the "Linnean House Pools." Here will be found the immense Victoria lilies, which with a few others are tropical in their habit and require the water heated to a temperature of about 90°F.

The history of water-lilies dates as far back as the ancient Egyptians who held the so-called Egyptian lotus as a sacred flower. It was also deemed sacred by the natives of India, Thibet, China, and Japan, and is still employed in religious invocations and ceremonies to a great extent.

Nymphaeas (Night-Blooming).—The nocturnal lilies (*Nymphaea Lotus*) are natives of tropical Asia and Africa. These are the largest and handsomest of the flowering water-lilies. The original species are *Nymphaea Lotus dentata,*

pure white, and *N. Lotus rubra,* pink. *Nymphaea Devoniensis* has the distinction of being the first hybrid among the lotus type, it being produced at the famous aquatic gardens of Chatsworth, England.

The work of originating new hybrids has been carried out extensively in this country where climatic conditions are far superior to those of England. Some excellent hybrids have originated in St. Louis through the efforts of Mr. James Gurney, such as "Frank Trelease," "D. R. Francis," "Rufus J. Lackland," and "James Gurney," the latter being the darkest of all water-lilies. The flowers are seen at their best before eight o'clock in the morning or after seven in the evening, for just as soon as the sun begins to shine brightly they close their petals. However, during cloudy weather the petals remain open day and night.

Such plants are grown as perennials. In the fall during October they are dug from the ponds, leaving a small ball of mud attached to the roots. They are then placed in the greenhouse to "dry off," a temperature of 50°F. being maintained. When well-dried the clumps are cleaned, care being taken to retain the small tubers which are attached to the dried-up tuber. They are then placed in dry sand until the end of February or March, when they are potted and placed in tanks of water at a temperature of 70–75°F. In May they are transplanted into the permanent ponds outside.

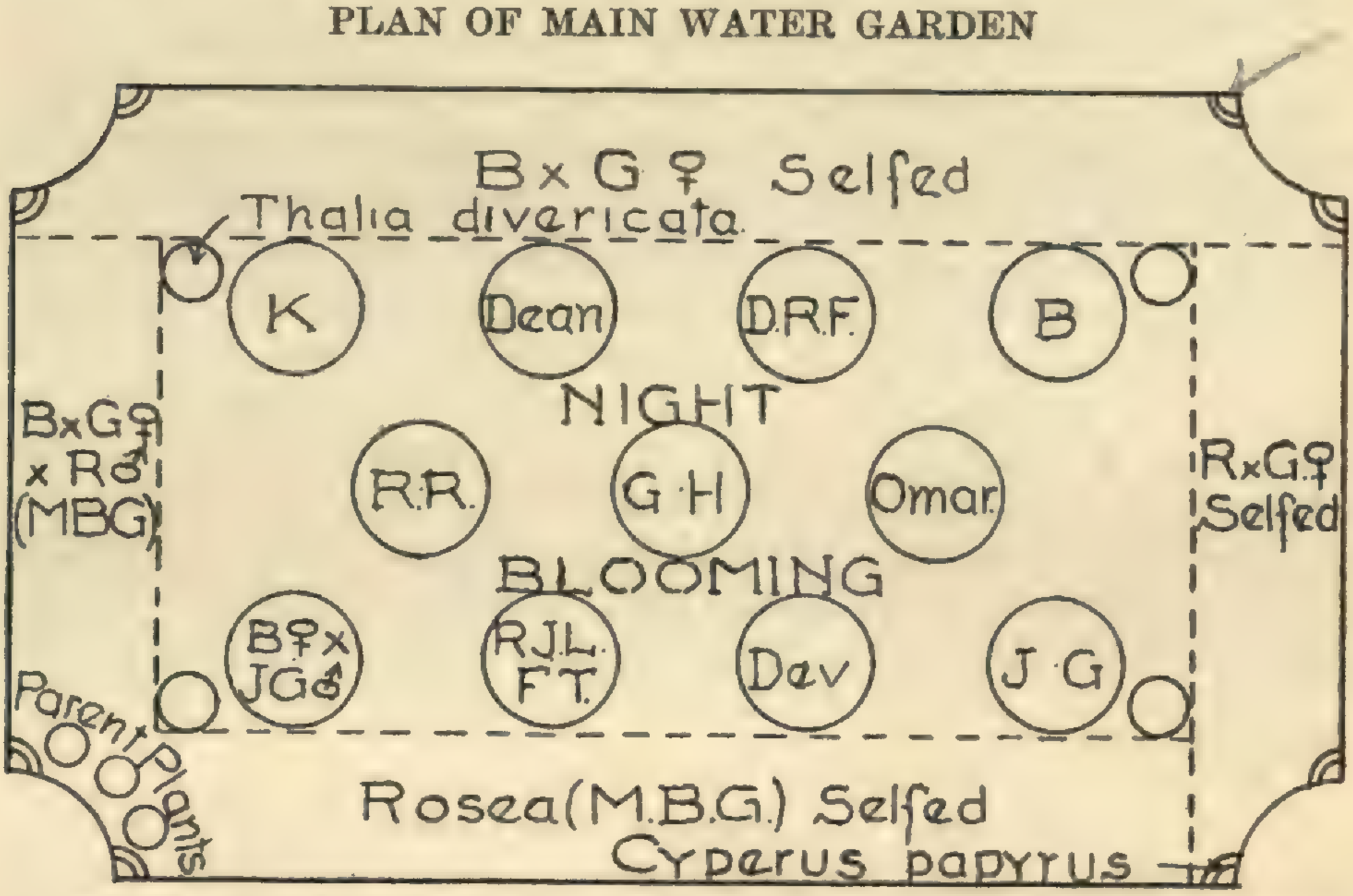
Nymphaeas (Day-Blooming).—The day-blooming lilies open their petals full in the bright morning sun and keep them open until afternoon—quite the reverse of the lotus type. They are also more tender plants and produce smaller and less showy flowers. This type has many blue varieties. *Nymphaea gigantea,* a native of Australia, is a light blue lily and though large is the most tender of the nymphaeas. Seeds of this species were obtained during the winter and upwards of a dozen plants of the varieties "Sturtevanti" and "Hudsoni" were raised. These may be seen in the Linnean House Pools. *Nymphaea coerulea* is another light blue lily. This variety is a native of Egypt and is supposed to be one of the true water-lilies of the ancient Egyptians.

Nymphaea zanzibariensis and its variety *rosea,* natives of Africa, are the commonest of the day-blooming lilies, the former being the royal purple and the latter the pink variety. These two varieties readily intercross, producing both dark blues and reds. *Nymphaea gracilis,* a white day-blooming lily and a native of Mexico, intercrosses with the zanzibariensis types producing medium-sized, stellate flowers which frequently rise two feet above the water. Several experi-

ments are being carried on with this parent by which it is expected to realize some new hybrids this summer.

The day-blooming lilies do not stand the "drying off" treatment as the lotus type does. If grown as perennials, it is necessary to plant them in tubs in the winter. However, better results are obtained by treating them as annuals. The

PLAN OF MAIN WATER GARDEN



Night-Blooming: K., Kewensis; Dean., Deaneana; D. R. F., D. R. Francis; B., Boucheana; R. R., Rubra rosea; G. H., George Huster; Omar., O'Marana; J. G., James Gurney; R. J. L., Rufus J. Lackland; F. T., Frank Trelease; Dev., Devoniensis.

Day-Blooming: All hybrids except Rosea.

seeds should be sown in tubs or small pans in the fall, and in January potted individually and placed in the tanks provided for their winter treatment.

Hardy Nymphaeas.—The native lilies and their hybrids are perfectly hardy, that is, the rhizomes or roots may be left in the ponds throughout the winter. The best hybrids have originated from three native species, *Nymphaeae odorata,* white, *N. odorata,* pink, and *N. flava,* yellow. It was this yellow-flowered variety that attracted the French hybridist, Latour Marliac. He crossed *N. tuberosa* and *N. flava,* thus originating the beautiful hybrid, *N. Marliacea chromatella.* The influence of this yellow species may be traced in the majority of hardy lilies. The first hybrid that appeared in pink or rose was *N. Marliacea rosea* in 1887, the parentage of this plant being known only to the hybridist. The European rose-colored lily, *Nymphaea alba rosea* was

also an acquisition. At the present time we have pure whites, dark yellows, and various pinks shading to dark red. Representatives of these may be seen in full flower in the first pond between the knolls.

Nelumbium.—*Nelumbium speciosum* is a native of India and was held sacred by the Hindus. It was early introduced into Egypt and is erroneously taken for a native Egyptian plant. In Cary's translation of Herodotus speaking of the Egyptians, it is recorded: "But to obtain food more easily, they have the following inventions: when the river is full, and has made the plains like a sea, great numbers of lilies, which the Egyptians call lotus, spring up in the water; these they gather and dry in the sun; then having pounded the middle of the lotus, which resembles a poppy, they make bread of it and bake it. The root also of the lotus is fit for food, and is tolerably sweet, and is round and of the size of an apple. There are also other lilies, like roses that grow in the river, the fruit of which is contained in a separate pod that springs up from the root, in form very like a wasp's nest; in this there are many berries fit to be eaten, of the size of an olive stone, and they are eaten both fresh and dried."

It is believed that the popular error that the Nelumbium was a native Egyptian plant arose from this statement of Herodotus. One of the most complete books dealing with this subject is the excellent volume by Professor Wm. H. Goodyear, entitled "The Grammar of the Lotus." In this work it is pointed out that *Nymphaea Lotus* or *N. coerulea,* the former the white, the latter the blue lotus, both native Egyptian plants, are the types of lotus which figure in the ornamental patterns of Egyptian monuments. He states: "The 'Rose Lotus' may possibly be realistically represented in ancient Egyptian paintings just as the Palm and many other plants appear, but such cases must be extremely rare, as none can be found in the great folio publications of Egyptian antiquities, or in the typical ornaments exhibited by Egyptian museums. As far as the typical ornaments or typical patterns are concerned, the 'Rose Lotus' is not to be found."

Nelumbium luteum, the yellow-flowered species, is native to North America. The seeds are also edible and are commonly called "water chinquapins," especially in the southern states. The plant grows very abundantly around the edges and shallow places of Creve Coeur Lake, St. Louis County. The peltate leaves fastened reversely are frequently used by the ladies for sunbonnets.

LINNEAN HOUSE POOLS

Victoria Regia (*Giant Water Platter*).—The date of the discovery of the giant water-lily is probably the year 1801 when the botanist Haenke was sent by the Spanish government to investigate the vegetable productions of Peru. His records have unfortunately been lost to science. M. A. D'Orbigny says: "When I was travelling in Central America, in the country of the wild Guarayas, who are a tribe of Guaranis or Caribs, I made acquaintance with Father La Cueva, a Spanish missionary, a good and well-informed man, beloved for his patriarchal virtues and who had long and earnestly devoted himself to the conversions of the natives. The traveller who, after spending a year among the Indians, meets with a fellow-creature capable of understanding and exchanging sentiments with him, can easily appreciate the delight and eagerness with which I conversed with this venerable old man." In one of these interviews he mentioned that he was with Haenke in a canoe on the Rio Mamoré, one of the tributaries of the River Amazon, when they discovered in the marshes by the side of the stream, a flower so unusual and beautiful that Haenke fell on his knees in a rapture of admiration.

Ten years later M. Bonpland discovered the same plant near the town of Corrientes, where it is known to the natives by the name "Mayz de l'agua" (maize of the water), owing to the seeds being substituted for grains of maize. The women of Corrientes, when the fruits are ripe, grind the seeds into flour and prefer this farina to flour made from the finest wheat; with it they make pastry, etc., which is considered a luxury. Dr. Poeppig, during his residence in South America from 1827–1832, noticed this species in the Amazon River. He refers to it as *Euryale amazonica.*

Introduction and Cultivation.—Five years after Dr. Poeppig's discovery, Sir Robert H. Schomburgk discovered specimens of the giant lily in British Guiana. In 1842 he again detected the plant, this time in the Rupunini River, a branch of the Essequibo. Up to this time only herbarium specimens had been introduced into Europe. Sir Robert, however, repeatedly sent roots and seeds with mud to England. One plant was reported raised from seeds, but died shortly after. The successful cultivation was finally accomplished at Kew Gardens. The following account is taken from John Smith's records of the Botanic Gardens:

"In February, 1849, seeds were received sent in a phial of water from Demerara by Dr. Boughton, which vegetated and in March six plants had become fully established, and

grew rapidly, in May one of them filling a shallow tank nine feet in diameter. Application was now made to the Commissioners of Woods and Forests for a large tank to grow it in, and accordingly slate sides ten feet high were put up, forming a tank on the slate floor of the Orchid House. A tank was thus formed 25 feet long by 11 feet wide, and on the 21st of August mould was placed in the center, and a plant planted, which grew rapidly, and on November 24th produced a flower bud, which on account of dull weather of that season of the year did not come to perfection.

"A plant having been early in the spring promised to the Duke of Devonshire, provided he had a proper tank for it, he quickly had one prepared, and on the 3d of August, 1849, our second sized plant was given to Mr. Paxton, and the next day planted in his tank. It thus had about three weeks' start of Kew, and flowered on the 9th of November.

"During the winter these first plants at Kew gradually dwindled away and died, but having a stock of young plants another was strong enough to put in the tank on April 16th, 1850, which produced its first flower on June 20th, and continued to produce a flower almost every alternate day up to November 25th when its sixty-fifth flower opened. After that they became fewer, and it produced its last flower on Christmas day. The leaves were four and a half feet in diameter, and lying nearly half over the side of the tank, eleven feet being much too narrow.

"The nature of the plant being now better understood, it was preserved throughout the winter, and in the spring began to grow vigorously, its first flower opening on Easter Monday, the 20th of April, 1851. It continued to flower, but with some intervals, up to the end of December; the plant again lived throughout the winter, and on February 28th, 1852, again commenced to flower, continuing to do so until late in the year. In January, 1853, it died, having been nearly three years in the tank, in that time producing more than 200 flowers, and a great abundance of seeds, thus proving the plant to be a perennial."

In 1851 seeds were sent from Kew by Sir Joseph Hooker to Mr. Caleb Cope, Esq., of Springbrook, near Philadelphia, which germinated on the 10th of April, 1851, the second leaf appearing a week later. On August 10th the twenty-seventh leaf appeared. This leaf grew to 6 feet 6 inches in diameter, being six inches larger than any produced in England. On August 21st the first flower was seen. The plant continued in perfect health for four years, during that period bearing over 200 flowers.

The next plant to bloom was at Salem, Massachusetts, at the residence of Mr. John Fisk Allen, who successfully flowered it on the 10th of July, 1853. Up to this period the Victoria was grown in greenhouses. Later growers, especially in the middle west, deviated from this treatment to outside cultivation, owing to favorable climatic conditions during summer. Mr. Shaw was one of the first to introduce the Victoria in the West, the St. Louis climate being well adapted to this plant. Mr. Gurney, Superintendent of Tower Grove Park and Head Gardener Emeritus of the Garden, has attained remarkable results in growing specimens, some over eight feet in diameter and capable of bearing the weight of a 200-pound man having been produced.

The Victoria lilies are now treated as annuals. Seeds are germinated in heated tanks in the greenhouses during March and later are transplanted into large pans and grown in the house until outside conditions are favorable. In the early part of June they are transplanted into the outside ponds, their leaves then averaging a foot across. The development of the leaves is extremely rapid and by August they have attained their maximum size. The recently completed formal pond in the Linnean House Garden is planted with the two types of Victoria, *Victoria regia* and *Victoria Cruziana,* this latter variety being a hardier form.

An interesting fact for the first time recorded in this locality is that of *Victoria Cruziana* germinating from self-sown seeds. This is an annual occurrence with *Euryale ferox,* but not so with Victoria. Several hundred seedlings are appearing in the center of the large formal pond. The water was left in the pond throughout the winter but during April was drained off in preparation for fertilizing. That the seeds were well covered during the spading under of the manure is evidenced by the enlongated radicle of the seedlings measuring in some cases six inches.

Euryale ferox.—Prior to the introduction of the *Victoria regia,* the Euryale was looked upon as the giant lily. This plant is indigenous to India, and like the Victoria, the seeds are edible, being gathered by the natives and ground into flour or baked. This plant, however, is not as handsome a specimen as its Amazonian neighbor, possessing neither the large white fragrant flowers nor the platter-like leaves. The leaves grow flat measuring four and five feet across and the flowers, which are deep purple, are small and insignificant. Euryale is perfectly hardy in St. Louis, that is, the plant will resow itself in the ponds during summer. The following spring the seeds will germinate readily, it only being necessary to thin out the young plants. A representative

specimen of this plant will be found in the center section of the Linnean House Pools.

To any one wishing further information or descriptions of water plants, two excellent publications are displayed on the tables in the Museum of the Garden. They are "The Book of Water Gardening," by Peter Bisset, and "Victoria Regia," by John Fisk Allen. The keeper will be pleased to show them to visitors.

STATISTICAL INFORMATION FOR JUNE, 1915

GARDEN ATTENDANCE:

Total number of visitors	20,989

PLANT ACCESSIONS:

Total number of seed packets received in exchange	7
Plants distributed	868

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	12
Total number of books and pamphlets donated	97

HERBARIUM ACCESSIONS:

By Purchase—	
A. Nelson—Plants of Colorado	340
Rev. John Davis—Plants of Missouri	240
By Gift—	
E. Bartholomew—Specimens of fungi from Colorado and Minnesota	3
J. C. Blumer—*Senecio microdontus* (Gray) Heller from Arizona	1
Boyce Fibre Co.—Fibre of *Asclepias incarnata* L. from Michigan	1
W. G. Farlow—Specimens of fungi from Mexico and Cuba	7
P. W. Graff—Fungi of Connecticut	45
J. M. Greenman—Krieger's "Schädliche Pilze" from Germany	40
J. M. Greenman—Fungi from Delaware and Missouri	8
J. Macoun—Fungi of British Columbia	92
C. E. Owens—Fungi of Oregon	9
Miss E. M. Wakefield—Fungi of England and Australia	5
J. A. Wier—Specimens of *Thelephora* from Idaho	2
By Exchange—	
U. S. National Museum—Specimens of fungi from New Mexico	146
TOTAL	939

The Garden is open to the public week days the year 'round from 8:00 A. M. until one-half hour after sunset. Until November 30, the Garden will be open Sundays from 2:00 P. M. until sunset. Admission free.

Personally conducted trips through the Garden every Saturday afternoon from May 1 to November 1, starting from the main gate at 3 o'clock. Other trips may be arranged for by special appointment.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

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Mycologist and Librarian.

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C. R. FOLLEN,
Construction.

G. H. PRING,
Orchids and other Exotics.

P. FOERSTER,
Farm and Stables.

M. SCHILLER,
New Conservatories.

K. N. SVETLIKOFF,
Plant Breeding and Seeds.

MISSOURI BOTANICAL GARDEN BULLETIN

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1915
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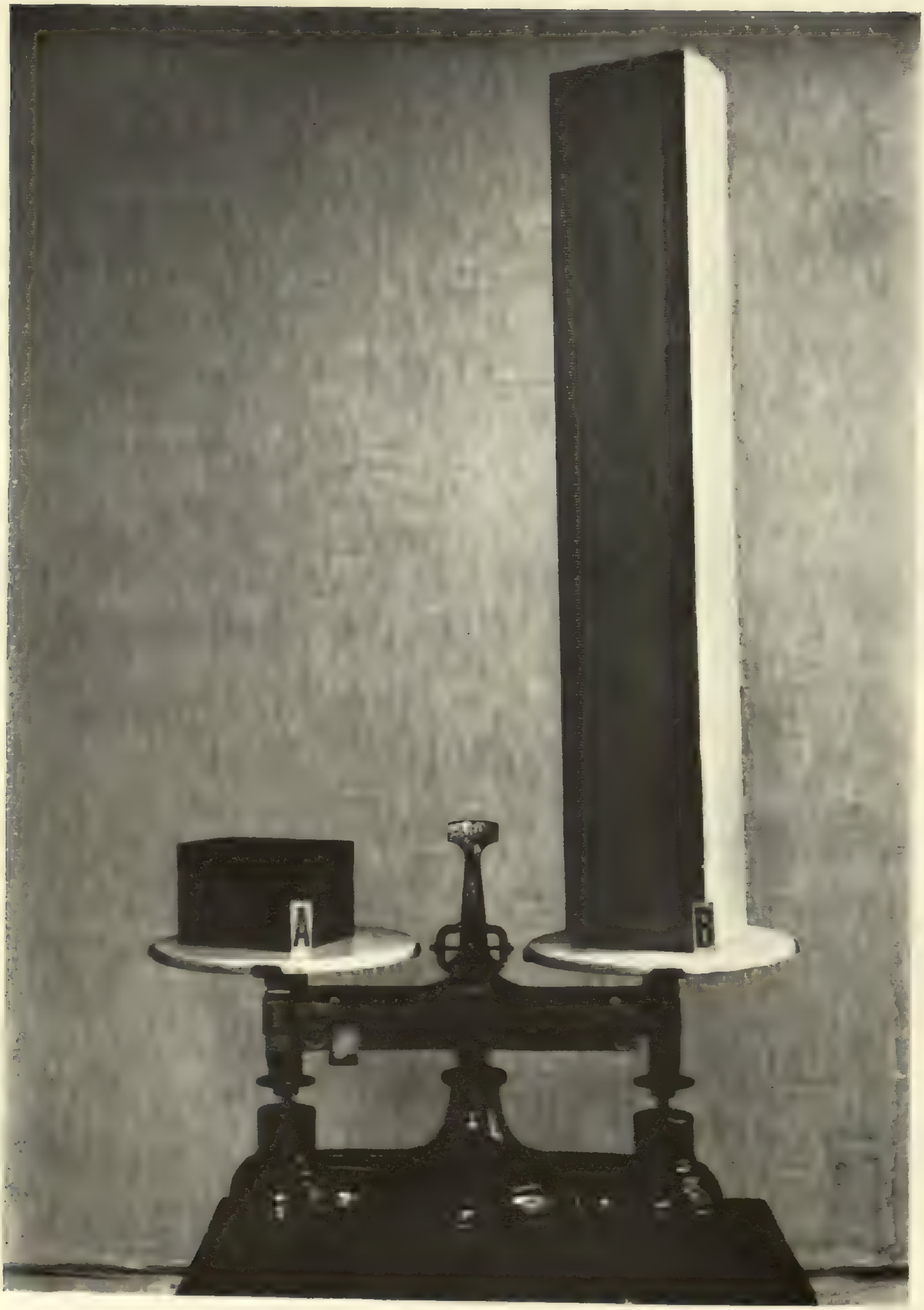

BALSA WOOD (B) BALANCED WITH IRONBARK (A).

Missouri Botanical Garden Bulletin

Vol. III St. Louis, Mo., August, 1915 No. 8

THE LIGHTEST KNOWN WOOD

During the past month some samples of a very interesting wood, known commercially as Balsa wood, have been installed in the Museum at the Missouri Botanical Garden. Balsa wood is cut from a tree known scientifically as *Ochroma Lagopus*, belonging to the order Bombaceae. It is closely related to the silk cotton tree, or Ceiba (*Eriodendron anfractuosum*). *Ochroma Lagopus* grows throughout the West Indies and Central America. In reporting on the forest trees of Porto Rico, Professor John C. Gifford states that it is one of the commonest trees in Porto Rico. In a recent letter received from Prof. Gifford, he states, "*Ochroma Lagopus* is scattered all over the West Indies wherever I have been, but 'scattered,' seldom in bunches of any consequence. Trees grow to be a foot or more in diameter. I have never seen any big ones." The wood is known by various common names. In Porto Rico it is goano or corkwood; in Martinique it is known as floating wood; in Cuba as lanero.

Balsa wood is of very great interest because of its extreme light weight. In fact, so far as known, with the possible exception of one of the species of pond apple (Anona), it is the lightest known wood. In the accompanying photograph a piece of Balsa wood is shown on one side of a pair of scales in comparison with a piece of ironbark (*Eucalyptus leucoxylon*) from Australia. The two pieces of wood are of exactly the same width and thickness, but the piece of Balsa wood is about ten times the length of the ironbark, and yet both sides of the scales balance. Balsa wood has a specific gravity of .11, weighing about 7.3 pounds per cubic foot. Ironbark has a specific gravity of 1.13, or a weight of 70.5 pounds per cubic foot; that is, it is about ten times as heavy as Balsa wood. The extremely light character of the wood is well shown in the accompanying comparative table showing the weight in pounds per cubic foot of various American woods:

COMMON NAME	SCIENTIFIC NAME	WEIGHT LBS. PER CU. FT.
Balsa	*Ochroma Lagopus*	7.3
Cork	(from cork oak, *Quercus Cuber*)	13.7
Missouri corkwood	*Leitneria floridana*	18.1
White pine	*Pinus Strobus*	23.7
Catalpa	*Catalpa speciosa*	26.2
Cypress	*Taxodium distichum*	28.0
Douglas fir	*Pseudotsuga mucronata*	32.4
Sycamore	*Platanus occidentalis*	35.5
Red oak	*Quercus rubra*	40.5
Maple	*Acer saccharum*	43.0
Longleaf pine	*Pinus palustris*	43.6
Mahogany	*Swietenia Mahagoni*	45.0
Locust	*Robinia Pseudo-Acacia*	45.5
White oak	*Quercus alba*	46.8
Hickory	*Carya alba*	54.2
Live oak	*Quercus virginiana*	60.5
Ironbark	*Eucalyptus leucoxylon*	70.5
Lignum-vitae	*Guaiacum sanctum*	71.0
Ebony	*Diospyrus Ebenus*	73.6
Black ironwood	*Krugiodendron ferreum*	81.0

Until recently it was supposed that the Missouri corkwood (*Leitneria floridana*), small trees of which are growing in the Garden, was the lightest. It will be noted that this weighs 18.1 pounds per cubic foot as compared with 7.3 pounds per cubic foot for Balsa wood. Another striking comparison is with cork. Ordinary cork weighs about 13.7 pounds per cubic foot; that is, it is about twice as heavy as Balsa wood.

The ironbark shown in the photograph comes from Australia, and is being extensively imported to the United States, particularly for use as rudder posts for ships, where it is especially serviceable because of its great strength and resilience.

In Porto Rico and other West Indies, Balsa wood has been used probably for a great many years for floats. The Consul General of Costa Rica has kindly advised that he remembers using pieces of Balsa wood during his boyhood while swimming, and that there was nothing equal to it for that purpose. Prof. Gifford says that in the West Indies the natives use it for poles "somewhat as the Chinese use bamboo for shoulder poles, tobacco poles, etc., all uses where a light, rather strong pole is needed."

The physical characteristics of the wood have not yet been fully determined. It is extremely soft and can readily be indented with the finger nail; is easily cut with tools, planes well and is remarkably uniform in texture. The pieces received at the Garden have no sign of any defects, such as knots and checks. Balsa wood has the characteristic uniform

growth frequently noted in tropical species; that is, no annual rings are visible. As might be expected, the percentage of actual fibre per cubic foot is very small; in other words, the wood is made up of very thin cell walls filled with air, giving it an extremely spongy texture. It has very little, if any, true wood fibre, as the cells are almost parenchymatous. For so light a wood, it appears remarkably strong but from information received, its lasting power is very slight. It absorbs water rapidly, and, unless impregnated in some way to protect it against water absorption, will become waterlogged very quickly. However, it is extensively used when thoroughly impregnated with paraffin.

Balsa wood has only recently come into commercial use in the United States, being imported chiefly from Costa Rica. It is now being used very largely after treatment with paraffin for making the floating parts of modern life preservers and for constructing life rafts. (A complete life raft of Balsa wood is exhibited in the Museum at the Garden.) It is also being employed by the Government for buoys and floating attachments to signals. Another use to which it is being extensively introduced is for interior linings of refrigerators. Owing to its extremely porous nature it acts as an excellent insulator against heat and cold, and from some tests recently made with a specially constructed Balsa wood box, it was found that when used as a fireless cooker, articles put into the box at night retained the heat until the following morning; on the other hand, a piece of ice remained in the box from five to six hours during the middle of a very hot day.

It is probable that, with a wider recognition of the peculiar characteristics of the wood, many other uses will be found for it in the near future.

VANILLA

The fine specimen of the vanilla orchid (*Vanilla planifolia*) growing in the epiphytic orchid house is now in bloom and for the next few weeks will be an object of particular interest. The vanilla is probably the only orchid of great economic importance. It is a native of Central America but is grown extensively in the Seychelles Islands, Réunion or Bourbon Island, and the Society Islands. So important has the industry become that in the small island of Tahiti the crop for 1897 was valued at nearly $175,000, and in the Seychelles Islands the annual yield was estimated at $246,000, while as early as 1892 the industry yielded to Réunion over half a million dollars.

The specimen growing at the Garden was planted about twelve years ago and within five years the plant had begun to assume its native epiphytic habit. At the present time visitors are somewhat puzzled to find the parent stem, the base of the original having died, but a close examination will reveal numerous roots descending from the overhead growths into the soil below.

Pollination of Flowers.—For the production of the vanilla beans under glass it is necessary to pollinate the flowers by hand. This should be done early in the morning or never later than noon because of the closing of the flowers in the afternoon. The pollinating stick is quite primitive, being made from any hard wood cut to about the size of a lead pencil and sharpened to a very thin point. The operation of uniting the sexual organs is very simple. They are situated at the end of the column which is enclosed by the labellum or funnel-shaped lip. The clinandrium (the chamber at the top of the column in which the pollinia lie) is gently raised securing the mealy pollinia at the same time to the stick. Immediately below is the stigmatic surface; this is entirely covered by the rostellum commonly called the "cap" which is fastened at the top by a hinge-like appendage. This cap should be raised by the pollinating stick and then by giving a little turn the pollen masses will adhere to the stigma below. When the cap is released it will spring back to its original position, thus preventing the loss of the pollen and securing it to the stigma.

If the fertilization is accomplished the flower persists until a few weeks before the ripening of the ovary. If not the flower will drop the second or third day. The pods or beans attain their full size within four months but do not ripen for about ten months. The indication of ripening is a slight yellowing of the whole pod which is more pronounced at the free end.

In its native country the pollination is accomplished by insects. The labellum is so arranged as to bring the insects in contact with the column. Attached to the interior of the labellum directly under the stigmatic surface is a stiff hinged brush with six divisions one above the other which lie flat facing the interior and raise individually. This peculiar structure would allow the insect to crawl with ease into the lip to secure its fill of nectar from the interior. But when it started to back out the divisions of the hinged brush would be raised forcing the insect against the pollen masses and attaching the pollen to its back. The same routine would be performed with the next flower visited except that on the outward journey the pollen masses would be scraped

VANILLA FLOWERS AT TOP WITH CLUSTER OF RIPE BEANS BELOW.

off by the cap or rostellum; this afterward would spring back bringing the pollen in contact with the stigma.

CULTIVATION IN THE SEYCHELLES

Vanilla cuttings are said to have been introduced into the Seychelles Islands in 1866, probably from Réunion where the plant was grown successfully after sugar began to fail in 1850. Plantations were gradually established and extended by the propagation of these original plants and from others subsequenly imported, and for many years the colony's prosperity has largely depended on vanilla.

Culture.—There are several methods of growing vanilla, but the method now most generally practised on these islands is to train each plant on a separate tree. Trees with moderately dense foliage which never become entirely defoliated and with plenty of low branches from 5 to 7 feet from the ground are selected; the branches act as a support and protect the vanilla from the strong sun. The soil most used is a rich vegetable mold, common enough in forest land.

Cuttings are then selected averaging from 6 to 10 feet in length, or long enough for the free end to hang over the fork of the supporting tree. These are planted during the rainy season around the bases of trees and tied in several places to prevent swinging. The material used for this purpose is a fibre called vacoa obtained from the screw pine or *Pandanus utilis.* A large specimen of this plant about twenty-five feet in height may be seen in the palm house at the Garden.

Under favorable conditions the plants are ready for cropping within eighteen months. Formerly they were allowed to grow until the dry spell prior to the usual blossoming time. The growing ends were then cut off and all new shoots removed as they appeared up to the flowering time or until the season for flowering had passed. This method was none too satisfactory, however, for flowers would sometimes come in spite of checking the growth. The modern method is to stop the growing ends some nine or ten months before flowering time. Later the shoots will appear farther back, and these are left for the next year's crop.

Curing the Pods for Market.—There are various ways of preparing vanilla, the most successful being the following: The pods are picked before ripening, usually when they show a light yellowish color. Lots of several hundred each are then placed in separate baskets. These baskets are then plunged in water at 190° F. for ten seconds; this is repeated

twice, the duration of the dips being increased to twelve and fifteen seconds with half a minute between each dip. After the third dip, when most of the water has been drained off, a blanket is folded between the series of pods treated. They are then placed in a wooden box or barrel lined with blankets and closely covered with the same material. Several thousand pods should be sweated in the same box as the more closely packed they are the better is the heat retained. By the following morning they should have changed to a chocolate color and are then ready to be placed on the drying shelves of the curing house.

The curing house usually consists of several rooms. The first chamber in which the pods are placed is called the hot room, it being kept at a temperature of 110° F.; the next room (the warm chamber) is kept slightly cooler and the other rooms are used as sorting rooms. The crop is usually kept in this house for three months before marketing, at the end of which time any pods showing a tendency to mould may be detected. All are then sorted and tied in bundles of fifty pods each and finally packed in twelve-pound tins. The extract is obtained by thoroughly soaking the pods in a mixture of alcohol and water.

NOTES

Miss Caroline Black, Assistant Professor of Botany at New Hampshire College, Durham, New Hampshire, is spending a few days at the Garden consulting the library.

Mr. Ernest J. Palmer, collector for the Missouri Botanical Garden, spent a few weeks in August at the Garden organizing the plants collected during his recent trip in the Southwest.

The August number of "The Gardeners' Chronicle of America" contains an article on "Producing Natural Effects in Conservatory Planting," by Mr. W. W. Ohlweiler, General Manager of the Garden.

Professor N. O. Booth, Professor of Horticulture at Oklahoma State Agricultural College, Stillwater, Oklahoma, is using the library and herbarium at the Garden in making a study of grapes and plums.

Mr. John Schnabel, Assistant Horticulturist at the Florida Agricultural Experiment Station, Gainesville, Florida, was a Garden visitor August 17. Mr. Schnabel was one of the gardeners of this institution several years ago.

Dr. R. R. Gates, who has been working in the library and herbarium for several months, has returned to resume his work at the Garden after a trip to California where he attended the meetings of the American Association for the Advancement of Science.

Mr. C. H. Thompson, Assistant Botanist, after a service of sixteen years in various capacities at the Missouri Botanical Garden, resigns September 1 to accept a position as Assistant Professor of Horticulture at the Massachusetts Agricultural College, Amherst, Massachusetts.

Recent visitors at the Garden include Prof. A. T. Erwin of Iowa State College, Ames, Iowa, one of the early graduates of the Garden course, Mr. A. G. Endres of the City Forester's office, Prof. Budington of Oberlin College, Oberlin, Ohio, Professor H. S. Jackson, Professor of Botany at the Oregon Agricultural College, Corvallis, Oregon, and Dr. L. H. Pennington, Professor of Forest Pathology at the New York State College of Forestry at Syracuse University, Syracuse, New York.

The Wardian case exhibited in the Nepenthes House, was planted November 16, 1914, with specimens of *Casuarina stricta, Canarium commune, Cerbera Odollam, Adenanthera pavonina, Lagunaria Patersonii,* and *Cassia calliantha.* The practical use of the Wardian case was demonstrated when it was unpacked on August 17, 1915, and showed the lagunaria, adenanthera, and cassia still in good condition, having been for nine months without water or open exposure to the air. Owing to the interest shown by visitors the case has been repacked with tender tropical plants for further demonstration.

STATISTICAL INFORMATION FOR JULY, 1915

GARDEN ATTENDANCE:

Total number of visitors	18,729

PLANT ACCESSIONS:

Plants donated	3
Plants distributed	49

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	119
Total number of books and pamphlets donated	32

HERBARIUM ACCESSIONS:

By Purchase—

Theo. Holm—Plants of Colorado, Maryland and Virginia	550

By Gift—

Geo. F. Atkinson—Fungus from North Carolina	1
E. Bartholomew—Fungus from Kansas	1
O. H. Bartlett—Fasciated specimen of *Dioscorea*	1
B. M. Duggar—Fungi from mushroom cellar	4
W. G. Farlow—Fungi of New Jersey	34
J. M. Greenman—Specimens of fungi from Missouri	3
E. Teas—Specimens of *Escallionia montevidensis* DC. and *Tecoma capensis* Lindl. cultivated at Houston, Texas	2
H. von Schrenk—Specimen of fungus, rotting cypress ties	1

By Field Work—

J. M. Greenman—Plants of Arcadia and Ironton, Missouri	74
TOTAL	671

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☞ **The Garden will be closed all day, September 6, Labor Day.**

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MISSOURI BOTANICAL GARDEN BULLETIN

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SINGLE PLANT OF BUCKET ORCHID

Missouri Botanical Garden Bulletin

Vol. III St. Louis, Mo., September, 1915 No. 9

THE BUCKET ORCHID

One of the characteristics of the subtribe Stanhopieae of the orchid family is its singularly shaped flowers. These are so unusual and grotesque in their appearance and structure that there is nothing quite like them found among the great variety of orchids, or even in the entire plant kingdom. Perhaps nowhere is the curious structure of this group of orchids more conspicuous than in the genus Coryanthes, of which there are upwards of a dozen species indigenous to tropical America. The partially opened buds resemble a bat at rest and when the flower is fully opened it reveals a "bucket," which holds the nectar and from which the plant receives its common name. Unfortunately, the flowers are of such short duration and the plant itself is so difficult to cultivate, that few have had the pleasure of seeing this floral curiosity. Visitors to the Garden within the next week, however, will have the unusual opportunity of being shown a fine specimen of the bucket orchid in bloom. Two species of Coryanthes were imported from the West Indies last year, one of which, *Coryanthes macrantha,* has produced two excellent flower spikes. The sepals, which are most delicate in texture, are yellow, spotted irregularly with dull purple. The lip, on the contrary, is thick and fleshy and is seated on a deep purple stalk, nearly an inch long, forming an obtuse angle with the column. This stalk terminates in a hemispherical greenish-purple cap (hypochile) and, contracting at its front edge, extends forward into a second stalk (mesochile), of vivid blood color. The latter is turned back and conspicuously marked with four or five deep edged plaits, the plaited edges extending from a second cap (epichile) which is yellow, streaked and spotted with crimson, and seems intended to catch a watery secretion which drops from the two succulent horns, originating from the base of the column.

Dr. Crüger, formerly Director of the Botanic Garden at Trinidad, writes as follows of his observations of the insects which pollinate the flowers:

"Large humble-bees, noisy and quarrelsome, are attracted at first by the smell of the flower; but the smell probably only gives notice to the insects; the substance they really come for is the interior lining of the labellum which they gnaw off with great industry. They may be seen in great numbers, disputing with each other for a place on the edge of the hypochile. Partly by contrast, partly perhaps intoxicated by the matter they are indulging in, they tumble down into the 'bucket' (epichile) half full of the fluid secreted by the horn-like organs at the base of the column. They then crawl along the anterior inner side of the bucket where there is a passage for them. If one is early on the lookout, as these hymenopters are early risers, one can see on every flower how pollination is performed. The humble-bee in forcing its way out of its involuntary bath has to exert itself considerably as the mouth of the epichile and the face of the column fit together exactly and are very stiff and elastic. The first bee that is immersed will have the gland of the pollen masses glued to its back. The insect then generally gets through the passage and comes out with this peculiar appendage, to return nearly immediately to its feast, when it is generally precipitated a second time into the bucket, passing out through the same aperture, and so inserting the pollen masses into the stigma while it forces its way out, and thereby pollinating either the same or another flower. I have often seen this, and sometimes there are so many of these humble-bees assembled that there is a continual procession of them through the passage specified."

The arrows marked on Plate 7 indicate the route of the bees.

While it is not usual to have many orchids in flower at the Garden this time of year, the cool, wet summer has been particularly favorable for the blooming of these plants, and various cattleyas and oncidiums, as well as single specimens of numerous species, will be on display the coming month. Hot, dry weather is detrimental to most orchids, particularly the cattleyas which grow wild in the Cordillera Mountains of Colombia, where the temperature rarely varies from 62°F. Under normal conditions these orchids make their new growths (pseudobulbs) during the summer months, storing sufficient material to produce the new flowers and carry the plant through the resting period. *Cattleya Gaskelliana,* a midsummer flowering variety, has bloomed profusely this month and *Laelio-Cattleya elegans,* recently imported from Colombia, commenced growing immediately upon arrival and has produced a number of flowers. *Oncidium variosum Rogersii,* imported during 1913 from Brazil, has made

BUCKET ORCHID FLOWERS

ARROWS SHOW ROUTE OF POLLINATING INSECTS

MO. BOT. GARD. BULL., VOL. 3, 1915.

remarkable growth and at the present time is flowering luxuriantly, over fifty tall spikes of abundant yellow flowers being in various stages of development. The cockroaches which infest the old range of greenhouses (fortunately soon to be replaced) are exceedingly partial to the young spikes of Oncidium, and unless the precaution is taken of spraying the plants with a poison, the pests gnaw the tender tips, thus destroying the flower spikes for the season. During April to September, 98 species of orchids flowered, some of which produced an abundance of blossoms.

FLOWERING PLANTS FOR ST. LOUIS

Gardeners in and about St. Louis have long known that but little dependence can be placed upon the directions for procuring continuous bloom in a garden when such directions are based upon European, eastern, or northern conditions. It is unfortunate that most of the best books on gardening have their origin either in foreign countries or have the limiting phrase, "periods of bloom are indicated in and about New York City." Because the weather conditions in St. Louis are entirely different from those in the East, all gardening schemes emanating from the latter source must be taken subject to trial. The trial will very often prove disastrous, but from the experiments one or two plants will prove to have been able to withstand the peculiar climatic conditions that occasionally make St. Louis a rather trying place for flower culture. However, there are many plants that grow to perfection in this locality that can hardly exist at all in the East, and if care is taken to make use of the advantages that the climate does possess, flourishing gardens will result.

Of course, by proper preparation and by transforming the garden into an infirmary, a few gentians, a little arbutus, or some of the native orchids that delight in the cool, moisture-laden air of the northern woods, may with diligent care be coaxed into bloom, but it would be a pity to try to bring up such weaklings when there are so many plants that enjoy and thrive on the heat and sunshine of our local climate.

Under certain conditions many exotic plants may be imported to this locality and, because they flourish so well, many gardens are resplendent with foliage plants from the tropics to the exclusion of indigenous material. Tropical gardens could be provided for, but the use of tropical foliage plants, i. e., coleus, caladiums (elephant ears), cannas, castor-oil plants, etc., is hardly justified except in formal plantations or distinctly tropical gardens, and hence this article

will not deal with this class of plants but will be devoted to those which can accomplish their whole development out of doors in and about St. Louis.

The use of the garden hose is almost imperative to a good garden in St. Louis and floral effects can hardly be obtained without constant and regular watering. However, much work may be saved if the soil in the beds or shrubbery borders is kept constantly hoed or cultivated. The primary object of cultivation is not to eradicate weeds but to pulverize the upper layer of soil and dry it out so that it will effectually prevent the evaporation of water from beneath. A mulch may also be obtained by spreading on the soil any such material as cut grass, manure, etc., but the soil mulch obtained from constant hoeing is better for the plants and should be reëstablished after every heavy rain. When water is applied with the hose, the soil should be thoroughly saturated and then followed by careful cultivation.

In general, flowering plants may be discussed by classifying them into four general groups, i. e., trees, shrubs, perennials, and annuals. The distinction between small trees and large shrubs is not very sharp, but a tree is usually considered as possessing but one main trunk, while a shrub may have several. Perennials, of course, are those herbaceous plants whose roots, being hardy, produce new growths each year. Annuals are those herbaceous plants growing and maturing from seed in one year. Some plants, ordinarily known as biennials because they mature the second year from seed, will be classed as perennials.

TREES

Flower gardens depend upon trees for background effect, although during the flowering and fruiting period the trees are as interesting, if not as showy, as the flowers themselves. Among the really showy trees as regards flowering, the following are a few which space permits mentioning.

Aesculus Hippocastanum or Horse-chestnut.—This tree usually attains a height of 50 feet or more and a spread of about 30 feet. It is usually rectangular in outline and rounded at the top and has a good, though rather coarse, foliage of a deep green color. Belonging to the same genus and of the same general habit is the buckeye. In early summer its large flower spikes of rather small flowers are very attractive, the varieties varying in color from red to cream and white. As garden subjects, fault is often found with these trees because of the number of fruits with their husks which fall to the ground after the first frost, but this

objection is only temporary and the individual flowers of the spike are very beautiful.

Aralia spinosa.—This is known also as the angelica-tree and is a shrub usually planted for high backgrounds, although in time it assumes the proportions of a small tree. Its general effect is tropical and each season masses of luxuriant, dark green foliage are produced from the spiny stems. The tree grows rapidly and for quick effects is even better than the sumacs. It produces large clusters of small white flowers in midsummer, but is more used as a foliage than as a flowering plant.

Catalpas.—These are quick growing, broad-leaved trees with light green foliage and are chiefly valuable as fillers between other trees when effects are desired quickly. Their masses of flowers are very showy and when properly cared for, these trees often attain great size. However, they are extremely brittle and usually become disfigured by the high winds long before maturity. The dwarf species known as *Bungei* is commonly seen about St. Louis, especially on terraces and in front of houses. Their use in gardening, except in formal gardens, should not be encouraged and in this connection the same may be said of the so-called "weeping mulberry."

Cercis canadensis.—The redbud (*Cercis canadensis*) is one of the best of our native spring flowering trees. It begins to bloom when only shrub size and really does not become tree-like until very old. The red flowers appear on the branches before the leaves and are very showy. There is also a white flowering variety of this tree which is but little known, a specimen of which stands in the Garden just south of the main entrance. The foliage of the redbud is fairly plentiful and light green in spring but in late summer it usually takes on a rusty appearance and looks shabby, although this does not in any way interfere with the growth of the flower-producing wood. This tree is typical of this region and no garden in St. Louis is really complete without it.

Chionanthus or White Fringe-tree.—This is a small tree or large shrub that often reaches 15 to 20 feet in height. It is valuable because of its dark green foliage and its trusses of fringe-like, white flowers. When once established the chionanthus is a good grower but is difficult to transplant.

Cornus.—Springtime always brings with it the showy cornus or flowering dogwood. Like the redbud, this tree blooms when comparatively young and it is not generally known that the showy part of the flower cluster is not the

petals but the colored bracts. The flower itself is the rather insignificant part at the center of the four white bracts. This is a beautiful plant for spring bloom, the flowers appearing before the leaves.

Crataegus.—These trees, commonly known as thorn trees or red haws, are valuable in the garden for their dark green foliage, their white or red flowers, and their bright red fruits of late summer. They belong to the rose family and like the apple, pear, and plum are profuse bloomers. They are covered with thorns which protect them from animal injury, but are breeders of the so-called scale insects, and unless carefully watched and protected against scale by spraying they will soon become so much damaged that removal is necessary. However, these trees are well worth while and should be included in the background of all shrubbery borders. They are found growing wild over the State and are perfectly adaptable to all local weather conditions. The same may be said of the cercis and the cornus.

Halesia or the Silverbell-tree.—This tree is always a good grower and is much admired for the pure white pendant bells of flowers that almost precede the foliage in spring. In habit and size it compares well with cercis, cornus, and chionanthus, and all of these may be included in the general background of the shrubbery borders.

Koelreuteria paniculata.—This is known also as the varnish-tree and is a tree of charming habit and beautiful appearance but unfortunately not well known about St. Louis. Like the maidenhair tree, it is a native of China but seems to take well to our climate. When the trees are given room in which to develop they make splendid, rounded specimens with branches clear to the ground, and might be mistaken for the native hornbeams or beeches. Moreover, in addition to their good foliage, they possess at flowering time in July, large panicles of showy, yellowish flowers, that are almost immediately followed by the bladder-like seed vessels.

Cladrastis tinctoria or Yellow-wood.—This is a tree that seems hard to grow but once established is very attractive. Specimen trees have a smooth grayish bark like the beeches and rather light green foliage, in the open developing a rounded top, like the beeches. The flowers remind one of the wistaria, and except that the cluster is much smaller, might be easily mistaken for the wistaria blooms. They are good shade trees, and well worth growing.

Liriodendron.—The common name for this is the tulip-tree. It is a desirable shade tree and one much used about St. Louis. The flowers are combinations of green and orange,

in shape and size resembling the tulip, hence the name. While not conspicuous the flowers are much admired and their return is always looked forward to in the spring.

Magnolias.—To one who has the patience to wait for their development, no tree will give better results in a floral way than the magnolia. Unfortunately most varieties bloom before the leaves open and the early flowers fall victims to the late frosts. However, *M. acuminata,* the cucumber tree, *M. glauca,* the sweet bay, and *M. tripetala,* the umbrella tree, all bloom later but are not nearly as important for their flowers as the early varieties. The really desirable magnolias for bloom are first of all, the star magnolia or *M. stellata,* then *M. Yulan,* both of which are white, but the former is a dwarf and the latter a tree-like species; *M. Soulangiana* for its large pink blooms, and then *M. Lennei* and *M. purpurea* for the reds. Imported magnolias usually bloom well the first season or so, but then rest for several years; after which they again begin blooming and are well worth the long wait.

(To be continued.)

NOTES

Professor Gentaro Yamada of the Higher School of Agriculture and Forestry, Morioka, Japan, was a visitor at the Garden, August 20.

Miss Alma G. Stokey, Assistant Professor of Botany at Mt. Holyoke College, South Hadley, Massachusetts, was a Garden visitor August 27.

Dr. B. M. Duggar, Physiologist to the Garden, has just returned from Texas, where he secured material for the study of an important fungous disease of cotton.

Mr. August Koch, in charge of Garfield Park conservatories, Chicago, spent several days in the Garden recently. Mr. Koch was formerly in charge of the economic collection at the Garden.

Dr. J. M. Greenman, Curator of the Herbarium, attended the twentieth anniversary celebration of the New York Botanical Garden, New York City, and also spent some time in their herbarium in the study of type material.

A noteworthy addition to the Garden collection of tender conifers is a remarkably fine collection of the Chilean pine, *Araucaria imbricata,* presented by Professor C. S. Sargent of the Arnold Arboretum. In nature this tree grows from fifty to one hundred feet high. The branches are horizontal, inflexed and ascending at the extremities, and are produced

in whorls. The leaves are sessile, thickened at the base, strongly mucronate at the apex, and are produced in whorls encircling the branches. A popular name given to the Araucaria is the "monkey puzzler," because it is supposed to be impossible for a monkey to climb. The plant will be found in the cycad and conifer house.

STATISTICAL INFORMATION FOR AUGUST, 1915

GARDEN ATTENDANCE:

Total number of visitors	24,416

LIBRARY ACCESSIONS:

Total number of books bought	17
Total number of books and pamphlets donated	60

HERBARIUM ACCESSIONS:

By Purchase —	
Rev. John Davis—Plants of Missouri	200
Th. Oswald Weigel—Plants of the Philippine Islands	300
By Gift —	
Ira W. Clokey—Plants of Illinois	133
Rev. John Davis—Plants of Missouri	400
B. M. Duggar — *Pleurotus spathulatus* from mushroom cellar	1
R. Ruggles Gates—Plants of California and Colorado	18
O. S. Ledman—Plants of Illinois	5
W. H. Long—Fungi from Arizona and New Mexico	16
Mrs. U. S. Price—*Hexalectris aphylla* (Nutt.) Raf. from Tennessee	1
J. B. Rorer—Pathogenic fungi of Trinidad	2
W. A. Thomas—Cultivated specimen of *Tamarix gallica* L. from Nebraska	1
C. H. Thompson—Specimen of *Isoetes* from California	3
H. von Schrenk—Fungi from Oregon and New Jersey	2
By Exchange —	
New York Botanical Garden—Fungi from southern Florida	18
U. S. Dept. of Agriculture—"American Grasses" Nos. 201–400.	200
TOTAL	1,300

The Garden is open to the public week days the year 'round from 8:00 A. M. until one-half hour after sunset. Until November 30, the Garden will be open Sundays from 2:00 P. M. until sunset. Admission free.

Personally conducted trips through the Garden every Saturday afternoon from May 1 to November 1, starting from the main gate at 3 o'clock. Other trips may be arranged for by special appointment.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

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P. FOERSTER,
Farm and Stables.

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New Conservatories.

K. N. SVETLIKOFF,
Plant Breeding and Seeds.

MISSOURI BOTANICAL GARDEN BULLETIN

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ST. LOUIS, MO.
1915

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THE ORIGINAL CHRYSANTHEMUM INDICUM CONTRASTED WITH A MODERN POMPON VARIETY DEVELOPED FROM IT.

CHRYSANTHEMUM PETALS FROM VARIOUS VARIETIES SHOWING THE CHANGES FROM THE ORIGINAL WILD TYPE (SMALL FLOWER NEAR CENTER) INDUCED BY SELECTION AND CROSS-BREEDING.

Missouri Botanical Garden Bulletin

Vol. III St. Louis, Mo., October, 1915 No. 10

THE EVOLUTION OF THE CULTIVATED CHRYSANTHEMUM

The chrysanthemums at the Garden this year will be shown in the new floral display house which has just been completed and, for the special purposes designed, is probably the finest in the country, if not in the world. The exhibition will be particularly noteworthy, comprising 3,000 plants of 500 varieties, among which are the following new specimens:

Bob Pulling (yellow)
Calumet (bronze)
Crystal Gem (large early white)
Earl Kitchener (amaranth, silvery reverse)
Garnet Gem (early bright red)
Golden Queen (early yellow)
Illona (lavender pompon)
Kewanee (buckskin or chamois)
Kewanee (yellow)
Mankator (amaranth)
Marigold (yellow)
Modello (orange)
Mrs. H. J. Jones ("green chrysanthemum")
Mrs. R. C. Pulling (yellow)
Mrs. T. P. Mitchel (white)
Rodi (purplish rose pompon)
Silver King (white)

The development of the cultivated chrysanthemum furnishes a most remarkable example of the ingenuity and perseverance of the plant hybridist. Although a 16-petalled chrysanthemum is the emblem of Japan and this flower is called the "flower of Japan," all evidence goes to show that the chrysanthemum is indigenous to China. Later it was imported to Japan, where it achieved a success far exceeding that in its native country. According to Chinese history, the chrysanthemum was cultivated in China over 2,000 years ago. Confucius, who supposedly lived 500 B. C., mentions the flower under the name, "Li-Ki," and some Chinese pottery, now preserved in the British Museum, which dates as early as 1426–1436, bears an exact replica of one of the earlier forms of the chrysanthemum. Previous to the importation of the chrysanthemum into Europe, the Chinese were known to graft certain kinds and cultivate specimens similar to the single-stemmed varieties of the present day. They even adopted a style of nomenclature, which bears

little resemblance to our modern system; for instance, one favorite was called "The Drunken Lady," owing to the drooping habit of the flowers during the day.

The earliest record of the introduction of the chrysanthemum into Europe dates from 1688, when it was brought into Holland by Breynius, a merchant of Dantzig, who, in the next year, published his "Prodromus Plantarum Rariorum," which contained accurate descriptions of the varieties then growing in Holland. In spite of its easy cultivation, however, interest in the chrysanthemum soon died out and the varieties described by Breynius passed out of existence in Holland. England is the next country to which we have any record of the chrysanthemum being imported, being brought this time in a dried state from China, in 1698–1703, by James Cunningham, Surgeon to the East India Company in Amoy, China. In 1764 living specimens were introduced into England; these were sent from Nimpu (probably Ningpo), China, and were cultivated by Philip Miller. The plants were also grown in the famous Chelsea Garden, in London, and it was from here that herbarium specimens were collected and preserved which are accessible at the present day. The specimens are labeled *Chrysanthemum indicum* and show flowers with small double heads, undoubtedly being one of the true "indicum" type.

The next important step in chrysanthemum culture was in 1789 when a French merchant, M. Blancard, brought home three varieties from China: one white, one violet, and one purplish. Within three years there was scarcely a garden in Versailles that had not adopted the chrysanthemum, the flowers then being about the size of the present-day carnation. M. Blancard's purple variety was introduced into England in 1790. Concerning this introduction, Sabine writes: "This is the purple variety; it had been transmitted to this country from France in 1790, and after its arrival here the changeable white was obtained from it by cultivation. Between the years 1798 and 1808, inclusive, eight new varieties were imported from China into England in the following order: the rose and buff together, in 1798; the golden yellow and the quilled yellow together, in 1802; the sulphur yellow at the latter end of the same year; the Spanish brown, in 1806; and the quilled white and large lilac together, in 1808. Of these the sulphur yellow was imported for Thomas Evans, Esq., of Stepney, and the remaining seven sorts for Sir Abraham Hume. Later importations have produced two others, the tasseled white, in 1816, and the superb white, in 1817."

For a considerable time after their introduction the French and English gardeners had been experimenting with the object of raising chrysanthemums from seed. Success was finally attained by a French officer, M. Bernet. The previous year he had discovered some withered flower heads in which he was surprised to find seeds bearing all the signs of perfect maturity. Keeping his discovery a secret he carefully tended the seeds himself, and in the fall of 1827 was rewarded with several fine varieties of plants.

In 1843 Mr. Robert Fortune was sent to China by the Royal Horticultural Society of London in search of rare plants. On his return in 1846 he brought, among other curiosities, two small-flowered chrysanthemums known as the Chusan Daisy and the Chinese Minimum. These, according to James Salter, were probably varieties from the true *Chrysanthemum indicum* of Linnaeus. The plants, however, did not find favor with the English growers owing to their small flowers, but they were appreciated by the French and were used for hybridizing. According to several authorities, the pompons of the present-day chrysanthemum originated from these two varieties. The introduction of the Japanese specimens into Europe dates from 1862, when they were brought back by Mr. Fortune from his second trip to China. Salter, in describing these new plants, says: "Some varieties were spotted and striped; others were fantastic forms called Dragons; and one noteworthy specimen was a beautiful fringed white flower, in appearance more like a Japanese pink than a chrysanthemum."

The development of the chrysanthemum before its introduction into Europe is a mystery. Hemsley states in the "Gardener's Chronicle," of 1889, that "it is impossible to determine the parentage of some of the Chinese double chrysanthemums, and it is highly probable that some of them are of hybrid origin between *Chrysanthemum indicum,* the small yellow, and *Chrysanthemum morifolium* (*sinense*). The same may be said with regard to some of the early figures of double varieties of chrysanthemums, which authors have identified with one or the other of the two adopted species. The slender Chusan Daisy, the parent of all the pompons, for example, is probably of mixed origin, though it may be pure *C. indicum.*"

The true *Chrysanthemum indicum* in its wild state is found from Hongkong to Pekin, the ray- and disk-flowers both being yellow. *Chrysanthemum morifolium* (*C. sinense*) is found in the Luchu Archipelago and the Chinese central province of Hupeh. It is more robust than *C.*

indicum, the leaves are thicker and tomentose, and the ray-flowers are a different color from the disk-flowers.

FLOWERING PLANTS FOR ST. LOUIS

In the previous number of the BULLETIN attention was called to the fact that the best background for the garden was trees and that those having conspicuous flowers offered a wide range of choice. In the use of shrubs other characters beside the flower are important in producing an effective landscape; for instance, in the fall and winter when the floral display is lacking, shrubs with brilliant foliage, scarlet berries or colored bark may all help to brighten up an otherwise dreary aspect.

There are many things to be considered in selecting flowering shrubs, for the variety is large and almost any effect desired may be secured by a proper selection of colors. An obvious, but frequently neglected, precaution in arranging the groups is to place the taller varieties in the background and the shorter ones in front. Of course, there are liable to be spots in the shrubbery border where it is desirable to have tall plants at the visible edge of the group, but in such cases plants as tall or taller should be placed behind them. Moreover, it is usually best to plant shrubbery in masses or small areas, and scattered groups about a lawn should be avoided. A border arrangement is good, using a few masses against the buildings and if lawn plants are desired, a tree may be planted in a suitable location. However, the placing of trees and shrubbery plantations is a matter that should not be attempted by the amateur without study, and it is always better to consult a landscape designer before undertaking anything more than the simplest arrangement. Planning a garden is quite as difficult a work to accomplish well as planning a house, and while many feel capable, in a small way, of designing a house they do not usually dispense with the advice of an architect, and a landscape designer is just as necessary for the garden.

The following list of shrubs that may be used in St. Louis has been chosen for their floral effect. The plants at the beginning of the list are designed for the background, while those at the end are to be placed in front, i. e., they are arranged according to size. Times of blooming are also given.

WHITE, CREAM, OR GRAY-FLOWERED SHRUBS

To be most effective plants with such light-colored flowers should be placed near the house or where they may be viewed

from a short distance, and the blooms are best brought out when massed against a background; in any case they should always be kept away from the sky-line.

Exochorda grandiflora.—This is a native of Japan and is commonly known as the pearl-bush. Clusters of pure white flowers are produced in May and June. This shrub is hard to transplant but when mature attains a height of 10 feet.

Hibiscus alba.—This shrub is sometimes called the althaea or rose of Sharon. Botanically, Althaea is the generic name for the hollyhock and the rose of Sharon should be known as the hibiscus. The varieties known as "Jean d'Arc," "Lady Stanley," and "alba pleura," are all white-flowered. As shrubbery subjects they do particularly well in St. Louis, and coming at a time when flowering material is rather scarce (August and September) makes them very desirable. The hibiscus tend to grow upright and do not spread much, and because they stand clipping well are much used for hedges. In height they range from 8 to 12 feet.

Philadelphus.—The common name for Philadelphus is syringa or mock-orange, but here, as in the hibiscus, there is a confusion of terms. Syringa is the generic name for the lilac and the shrub should be spoken of as the mock-orange. *P. coronarius, P. grandiflorus,* and *P. Gordonianus* are perhaps the best varieties, but *P. Lemoineii erectus* is also good, being from 6 to 8 feet high with a creamy white flower. As garden subjects they are valuable because of their height, their flowering season in June, and their masses of fragrant white flowers. The Philadelphus is probably one of the commonest shrubs grown in this locality but the foliage, contrasted with that of the hibiscus, which is a rich, dark green, presents a parched appearance in late summer. For this reason it should be used for the background or in places where it will not be conspicuous late in the season.

Rhodotypos kerroides or White Kerria.—This is a graceful shrub, a native of Japan, and valuable because of the number of small white flowers which come a few at a time, but continue blooming all summer. When well grown the plant becomes several feet tall, and while not showy is very attractive.

Sambucus.—In the sambucus or elderberry we have one of the most rapid-growing of the garden shrubs. Besides the large trusses or panicles of white flowers which bloom in May or June, the plants are also attractive when the elderberries become ripe in late summer. The variety, *S. nigra aurea,* is often used because of its golden foliage. Sambucus is a gross

feeder and strong grower and must be watched or it will monopolize the border. In height it runs from 8 to 12 feet.

Viburnum.—To this genus belong the snowballs, the choicest of the white-flowering shrubs. They make beautiful specimens because the flowers are well set off against the intense dark green of the foliage. One of the best varieties is *V. dentatum,* or arrow-wood, with its greenish white flowers followed by dark blue berries in the fall. The foliage is heart-shaped and turns purplish late in the season. This shrub blooms in May, as do all the viburnums, and is 6 to 8 feet high. *V. lantana* has large clusters of white flowers followed by red berries and the foliage does not shed until very late. It grows to be about 8 to 10 feet tall. About the same height is *V. Lentago,* or sheepberry, with its very fragrant creamy white flowers. *Viburnum Opulus* is called the high bush cranberry, because of the cranberry-like berries which are produced in late summer and hang on until after frost. The flowers of this species are also very attractive. Its sterile variety, *V. Opulus sterilis,* is the common snowball and needs no comment. *V. plicatum,* known as the Japanese snowball, is very seldom grown in this country, but deserves to be better known. In height it is about the same as in the preceding varieties, but the flowers are in larger heads and have the advantage of a long-blooming period. *V. acerifolium,* the maple-leaved viburnum, and *V. tomentosum* are varieties having the same desirable qualities as the others but are not as tall, being only about 6 to 8 feet in height. This particular genus of plants affords great satisfaction to the plant lover and some of the species should be in every border.

Xanthoceras sorbifolia.—The Chinese chestnut is a beautiful slow-growing shrub with creamy white flowers blooming in St. Louis in April or May. It should prove a fine subject for massing, although its slow growth will more probably cause it to be used for single specimens.

Baccharis halimifolia or Groundsel Tree.—This is a woody shrub of the Compositae group. The flowers are grayish white and do not bloom until September, while the seed pods are attractive up to frost. It is not a very showy plant, although growing from 6 to 8 feet in height.

Cornus.—The cornus, or flowering dogwood, blooms in June, producing grayish white flowers which are very attractive against the dark background of the foliage leaves. The flowers are followed by beautiful fruit clusters and the bark adds a bit of color in winter time. *C. alternifolia, C. paniculata,* and *C. sanguinea* are three varieties which grow from

6 to 8 feet high, while *C. sericëa* grows from 3 to 6 feet in height. *C. florida,* mentioned under trees in the last number of the BULLETIN, might be classed as a shrub during the first few years of its growth.

Deutzia.—The deutzias are of Japanese origin but have been much improved by the breeder since their importation. The flowers are mostly white, although a few varieties have a pinkish tinge when in bud. *D. candidissima, D. gracilis, D. Lemoinei, D. crenata,* and *D. scabra* are the best of the white-flowered deutzias. *D. gracilis* is a dwarf species from two to three feet high, while the others run from 6 to 8 feet. *D. crenata fl. pl., D. crenata Waterei, D.* "Pride of Rochester," and *D. rosea plena* are some of the pink-flowered varieties. Because of their vigorous growth and the beauty of their flowers they should be used in all borders where floral effect is desired in June or July.

Diervilla.—The diervilla, or weigelia, is vigorous in growth and is one of the best shrubs for St. Louis. It flowers in mid-summer and the foliage is a rich, deep green. The white varieties are *D. amabilis alba* and *D. candida,* both of which bloom in July and attain a height of 6 to 8 feet. They not only make very desirable plants for the shrubbery masses but also are good as single specimens. A single year's growth of the diervilla in the border will help more than any other shrub to give finish and an appearance of solidity.

Hydrangea.—*H. paniculata* and *H. paniculata grandiflora* are very desirable plants where medium height is desired, both usually reaching 6 to 8 feet. The size of the blooms depends very largely upon the method of pruning. In the winter all new growths from the previous season should be cut back to one or two eyes or buds; then with the use of plenty of manure in the soil, large flower clusters will result. In time shrubs so treated will become tree-like and single specimens sometimes attain a height of 8 to 10 feet with a spread of 10 to 15 feet. *H. arborescens* and its variety *grandiflora* are more dwarf, usually growing to about 4 to 6 feet high. The flower clusters of the large-flowered variety are particularly striking and have given rise to the names "Snowball Hydrangea" and "Hills of Snow." These seem to do better in a rather damp and shady location, although different conditions do not apparently affect its beauty. There is also an oak-leaved hydrangea from 3 to 6 feet tall called *H. quercifolia* which, though not so conspicuous in flower, is very attractive.

Lonicera.—*L. tatarica alba,* sometimes called Tartarian honeysuckle, is a strong, vigorous shrub attaining a height

of from 6 to 8 feet. It is particularly desirable for its rapid growth and excellent foliage. The flowers are fragrant and creamy white and are borne in great profusion in May and June. *L. fragrantissima* is another creamy white variety and very fragrant but is a much earlier bloomer, flowering in April and May.

Spiraea.—Spiraeas, or meadow-sweet, as a class, are very desirable garden subjects. The different varieties are quite unlike both in habit and in kind of flowers. They bloom in May and June, but even after the flowering season is over are worth while for their graceful masses of foliage. *S. opulifolia, S. opulifolia aurea, S. prunifolia, S. Reevesii, S. Reevesii fl. pl.,* and *S. Van Houttei* are all white-flowered spiraeas and run from 6 to 8 feet in height. *S. Thunbergii* is another white-flowered variety but is only 3 to 6 feet tall, while *S. colossa alba* is still smaller, being 2 to 3 feet in height.

Syringa or Lilac.—Many of the white varieties of lilac are very attractive in early spring, but after the blooming period they become mildewed and have a dusty appearance. Spraying with ammoniacal copper carbonate will help this to some extent but they have the further disadvantage of being irregular growers and of dropping their leaves very early in the fall. The white lilac, if used at all, should be planted in backgrounds and inconspicuous places.

Amygdalus alba.—This is commonly spoken of as the flowering almond and is one of the finest of the early flowering shrubs or small trees. The flowers are very showy and are borne in great profusion. The plants are clean growers and healthy in appearance.

Cephalanthus occidentalis or Button Bush.—This shrub grows from 3 to 6 feet high, and is valuable for its dark green foliage and its peculiar globular heads of white flowers which bloom in July. It does well in shady and moist places.

Clethra alnifolia.—This is known as the sweet pepper-bush. It grows from 4 to 6 feet high and bears masses of fragrant, grayish white flowers in June or July. It is a rather slow-growing shrub but a very desirable addition to local gardens.

Stephanandra flexuosa.—The Stephanandra is a graceful shrub with spreading, drooping branches and very pleasing foliage which turns purplish in the fall. The flowers are pure white and are borne in panicled racemes. This plant is not as much grown in St. Louis as it should be.

YELLOW-FLOWERED SHRUBS

Because yellow appears more intense against a background of green, it is usually advisable to use yellow-flowered shrubs

where they may be viewed from a distance. This is especially true where many colors enter into the garden scheme. In combination with red, purple, or blue, yellow is very attractive, but care must be taken to choose the right shades in the combination.

Elaeagnus angustifolia or Russian Olive.—The flowers of this species bloom in June and while not large are very numerous and fragrant, and are followed by silvery-coated yellow berries. This is a quick-growing shrub from 12 to 15 feet high and is used chiefly for the silvery effect of the foliage.

Caragana arborescens.—This is a hardy plant, commonly called the pea shrub, which thrives in almost any well-drained soil. The showy yellow flowers bloom in great profusion in late spring and early summer. In height it varies from 8 to 10 feet.

Forsythia or Golden Bell.—The forsythia is one of the best of the spring-flowering shrubs. As the flowers appear before the leaves on the wood of the previous year, pruning should be delayed until after the blooming period. This is, of course, true for any shrub that flowers on the wood of the previous season. The forsythias have both grace and beauty and combine excellent foliage with abundant flowers. The varieties, *F. intermedia* and *F. viridissima,* have an erect habit, while *F. suspensa* and *F. suspensa fortunei* are more drooping. The latter two with a little help can be used to cover very high walls, and when so grown are very beautiful. The upright varieties are from 6 to 8 feet in height, while the varieties of *F. suspensa* may grow under certain conditions as high as 10 to 12 feet.

Ribes aureum.—This is known as the Missouri currant. It is a rapid-growing shrub that is inclined to sucker badly but nevertheless is an admirable plant for the edge of the shrubbery border. Its habit of spreading tends to show to advantage the small yellow flowers which come in the early spring. In height the plant ranges from 4 to 6 feet.

Rhus aromatica.—The sweet-scented sumac is a much branched, spreading shrub usually 2 to 4 feet tall. It makes a beautiful plant for low corners of shrubbery masses with its rich, dark green foliage. The flowers which precede the leaves in the early spring are yellow, produced in short spikes or clusters along the branches.

Kerria japonica fl. pl.—This is a low-growing shrub, sometimes called the globe-flower, which makes a good edge for high shrubbery. It blooms nearly all summer, the flowers

being a type of golden yellow that is particularly beautiful in combination with *Vitex Agnus-castus.*

Berberis Thunbergii or Japanese Barberry.—This species has numerous, small, yellow flowers in the spring which are followed in the fall by bright red berries or fruits. It is most used as a hedge plant, but is particularly valuable as an edging for shrubbery borders, the thorny stems doing effective service in keeping out the traffic.

RED OR REDDISH-FLOWERED SHRUBS

As garden subjects the red-flowered varieties are seldom really attractive when used alone, the color showing to better advantage when combined with white, yellow, etc. In combination with blue they look purplish and with yellow an orange effect is produced. However, when the various colors are properly separated and counterbalanced the red or reddish flowers are very pleasing.

Hibiscus.—The hibiscus has been discussed before under white-flowering shrubs but the following red-flowering species should be mentioned: *H. rubra* (red), *H.* "Bonte de Feu" (deep rose), *H. Leopoldi* (deep rose).

Cydonia japonica or Japanese Quince.—The Japanese quince is a hardy shrub, invaluable for border planting and also making beautiful formal or informal hedges. The flowers bloom in early spring and are scarlet, large, and showy. There are also several varieties with double and single flowers in various shades of color, including white. The fragrant fruits are often used for making a tart, delicious jelly.

Diervilla.—*D.* "Eva Rathke" (crimson), *D. floribunda* (red), *D.* "Pres. Duchartre" (red), and *D. Van Houttei* (crimson) are a few of the diervillas that may be used where red is required. In pink we have the varieties *D.* "Abel Carrière" (rose pink), *D.* "camelon" (flesh pink), and *D. Verschaffelti* (pink).

Tamarix.—The tamarix grow well in any soil. *T. gallica* and *T. indica* with their finely divided foliage and delicate masses of pink flowers in May and June are the principal varieties. The grayish forms of tamarix are much used to vary the foliage effects in the border.

Lonicera.—*L. rubra grandiflora* is a vigorous honeysuckle producing in June, large, bright red flowers striped with white. *L. Morrowi, L. rosea,* and *L. Ruprechtiani* are pink varieties. These specimens grow from 6 to 8 feet high.

Robinia hispida or Rose Acacia.—Though this is a small shrub from 3 to 4 feet high, it is very hardy, spreading by underground rootstocks. The showy flowers are a rose-pink and appear in late spring or early summer.

Spiraea.—Among the spiraeas are the following pink or rose-colored varieties: *S. Billardi* (rose), *S. collossa* (pink), *S. Douglassi* (rose), *S. salicifolia* (rose), *S. Bumalda* (pink), and *S.* "Anthony Waterer" (crimson).

Syringa.—Among the syringas are many varieties that may be classed as pink or rose.

Desmodium penduliflorum.—This is a low-growing shrub which dies to the ground each winter but attains a height of about 3 to 4 feet during the summer. It is a beautiful specimen in flowering time in September with its branches a mass of rosy pink reaching to the ground, and coming at a time of the year when flowering shrubs are scarce is a valuable addition to any planting scheme.

Hibiscus Moscheutos or Mallow.—This is another shrub which dies to the ground in the winter. The large flowers are 6 to 8 inches across and come in all shades of red and also white. It is a rapid-growing plant and should be in every garden.

BLUE, PURPLE, AND VIOLET-FLOWERING SHRUBS

Amorpha fruticosa.—This is commonly known as the false indigo. It is a hardy, free-flowering shrub with feathery foliage, which thrives in sunny situations in well-drained soil. It is very valuable for border plantations or for massing on rocky slopes and banks, the unusual color of the flowers (purple) invariably attracting attention. The flowers grow in clustered racemes which are 3 to 6 inches long and the plant varies from 6 to 10 feet in height.

Hibiscus.—Among the varieties of hibiscus which have a purplish tinge may be mentioned the following: *H. ardens* (dark violet), *H. coelestis* (sky-blue), *H.* "Duchesse de Brabant" (lilac), and *H. purpurea* (purple).

Rhus Cotinus.—This is commonly known as the smoke-bush and is desirable for its height and the smoke-like masses of purplish flowers which come in midsummer.

Calycanthus floridus or Carolina Allspice.—This is a well-known native shrub growing from 6 to 8 feet high. The flowers which are produced after the leaves in June are double, brownish purple, and very fragrant.

Diervilla Lavellei.—This is a reddish purple variety of the diervilla which blooms in June.

Syringa.—Varieties of syringa are among the best of the lilac-colored flowers. Any florist's catalogue will give a number of varieties from which to choose.

Vitex Agnus-castus.—The popular name for this shrub is the chaste-tree. It is a graceful plant 5 to 6 feet high, bearing in late summer dense spikes of lilac-colored flowers. Reference to its use in connection with *Kerria japonica fl. pl.* has already been made.

Caryopteris Mastacanthus or Blue Spiraea.—This is not a very hardy plant but is well worth trying. It requires a well-drained and loamy soil, a sunny location, and a little protection in the winter. The lavender-blue flowers are borne in great profusion in the summer and continue blooming until frost. It grows from 2 to 3 feet high.

Buddleia Lindleyana.—The Chinese Buddleia or summer lilac is a beautiful free-flowering shrub, but requires a light porous soil and a sunny exposure for its best development. The violet-purple flowers bloom in midsummer and are produced in dense, arching racemes from 4 to 8 inches long. This is a splendid plant, growing from 5 to 8 feet high and holding the foliage until after frost.

(To be concluded.)

THE DOVE ORCHID

The dove orchid (*Peristeria elata*), an account of which was given in the December, 1914, BULLETIN, will again be in bloom the early part of November. Visitors to the Garden should not fail to ask where this plant is, since it is, as may be seen from the accompanying plate, one of the most curious and interesting orchids grown in the Garden collection.

CHRYSANTHEMUM SHOW

The annual display of chrysanthemums will be held in the new floral display house, beginning the last Sunday in October and continuing throughout the month of November. Both because of the number and variety of plants and the exceptionally fine house in which they are to be shown, the exhibit will surpass any previous display of this kind ever held at the Garden. The show will be open every week day from 8:00 o'clock until sunset and beginning with Sunday, October 31 until December, every Sunday from 2:00 p. m. until sunset. From December until Easter the Garden will be closed on Sunday, but throughout the winter a continuous display of blooming flowers will be maintained in the new

THE DOVE ORCHID

greenhouse which will prove of interest to those visiting the Garden on week days.

NOTES

On October 6, about one hundred of the alumni of the Washington University Medical School visited the Garden.

As a result of the competitive Garden scholarship examination held September 4, a scholarship was awarded to Mr. James Monteith, of St. Louis.

Mrs. T. S. Brandegee, of the University of California, spent several days in the Garden herbarium during October studying type material of various genera, particularly Lupinus and Oenothera.

Mr. W. W. Eggleston, of the Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C., visited the Garden, October 14, and spent the day examining material of Lupinus in the Garden herbarium.

Recent visitors to the Garden include Senor Adrian Recinos, Assistant Secretary of State of Guatemala and a delegate to the Dry Farming International Congress at Denver, on October 2, and Mr. Hal. B. Fullerton, Director Agricultural Development of the Long Island Railroad Company, on October 8.

Mr. G. H. Pring has started the new course of lectures on Economic Horticulture for the senior garden pupils. The course will be particularly interesting, as it embraces the study of plants of economic and industrial importance, special emphasis being given to the native and exotic representatives in the Garden collection.

The third number of Volume II of the Annals of the Missouri Botanical Garden has been issued with the following contents:

"Rhizoctonia Crocorum (Pers.) DC. and R. Solani Kühn (Corticium vagum B. & C.) with Notes on Other Species." B. M. Duggar.

"Some Relations of Plants to Distilled Water and Certain Dilute Toxic Solutions." M. C. Merrill.

"Electrolytic Determination of Exosmosis from the Roots of Plants Subjected to the Action of Various Agents." M. C. Merrill.

"Monograph of the North and Central American Species of the Genus Senecio—Part II." J. M. Greenman.

"The Thelephoraceae of North America IV." E. A. Burt.

Of the forty degrees of Doctor of Philosophy in botany conferred by American universities during the past college year, five were granted by Washington University to students

who did practically all of their work in the Graduate Laboratories at the Missouri Botanical Garden. The University of Chicago, with eight, and Cornell University with seven were the only two institutions which had a larger number of students in botany receiving the doctorate. Johns Hopkins, University of Pennsylvania, and the University of California had three each, while Harvard, University of Illinois, University of Michigan, and University of Nebraska each had two.

STATISTICAL INFORMATION FOR SEPTEMBER, 1915

GARDEN ATTENDANCE:

Total number of visitors	17,970

PLANT ACCESSIONS:

Total number of plants and seeds received in exchange	634
Total number of plants distributed in exchange	55
Plants donated	62

LIBRARY ACCESSIONS:

Total number of books bought	25
Total number of books and pamphlets donated	249

HERBARIUM ACCESSIONS:

By Purchase —	
A. A. Heller—Plants of California	280
By Exchange —	
New York Botanical Garden—Plants of Bermuda	37
By Gift —	
Geo. F. Atkinson — Specimens of *Tremellodendron* from North Carolina	5
A. R. Davis—Flowering plants from California	95
A. R. Davis — Fungi from California and the Philippine Islands	26
J. A. Drushel and L. M. Dougan—Plants from California, Colorado, and Missouri	8
B. M. Duggar—Fungus on cotton stalks from Texas	1
W. G. Farlow—*Sabacina* from New Hampshire	1
T. C. Frye—*Hormicia tetraciliata* Frye & Zeller from Washington	1
J. M. Greenman—Plants of Staten Island, N. Y	2
A. L. Kammerer—Plants of Washington	201
Geo. T. Moore—Private herbarium	413
Alfred A. W. Pavah — Fungi of Lake Superior region, Michigan	25
C. V. Piper—*Senecio Flettii* Wiegand from Washington	1
J. B. Rorer—Pathogenic fungi of Trinidad, B. W. I	8
H. von Schrenk — Fungi from Michigan, Arkansas and Texas	6
H. von Schrenk — Flowering plants from Michigan and Arkansas	3
TOTAL	1,113

The Garden is open to the public week days the year 'round from 8:00 A. M. until one-half hour after sunset. Until November 30, the Garden will be open Sundays from 2:00 P. M. until sunset. Admission free.

Personally conducted trips through the Garden every Saturday afternoon from May 1 to November 1, starting from the main gate at 3 o'clock. Other trips may be arranged for by special appointment.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

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M. SCHILLER,
New Conservatories.

MISSOURI BOTANICAL GARDEN BULLETIN

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Missouri Botanical Garden Bulletin

Vol. III St. Louis, Mo., November, 1915 No. 11

AN EXHIBIT OF THE CHESTNUT BARK DISEASE

Among the various fungous diseases which are destructive to trees, perhaps the one which attacks the chestnut bark has attracted more attention in recent years than any other. While there are few chestnut trees growing in Missouri, the number of inquiries which have come to the Garden concerning the blight indicate that there is considerable local interest in it, and an exhibit illustrating the effect of the fungus has been installed in the Museum building.

This disease of the chestnut was first discovered in New York in the year 1906. All the evidence at hand points to its having been introduced from the Orient with nursery stock about twenty-five years ago. From the vicinity of New York City it spread eastward and southward with an alarming rapidity, until at the present time the region infected extends from Maine on the north to North Carolina on the south. Not only has the spread of this disease been phenomenal, but it has literally swept everything before it, with the result that healthy chestnuts are now all but unknown in western Connecticut, southern New York, Delaware, New Jersey, and eastern Pennsylvania, and in the centers of worst infection every chestnut tree has been killed. The pest bids fair at the present time to wipe out completely the chestnut throughout its range along the Appalachian Mountains unless some successful method of attack should be found within a few years.

The chestnut bark disease is due to the fungus, *Endothia parasitica,* which attacks exclusively the chestnut and the chinquapin. This fungus can enter the bark only through wounds of various sorts, such as are caused by mechanical injury, insect punctures, woodpecker holes, etc. Once the fungus has started in the bark or cambium, it progresses very steadily and rapidly, and although it remains practically dormant during the winter months, growth is vigorously resumed with the return of warm weather. The cankers are produced on both the branches and the main trunk, and

are orange-colored or brown. In the course of time the branch or tree is girdled, resulting in the death of all parts above the canker. If the entire tree above ground is killed, numerous sprouts or "suckers" may be produced at its base, but these in turn fall a rapid prey to the attacks of the parasite.

Two kinds of reproductive bodies, or spores, are formed by the fungus. One of these makes itself evident after warm rains in the form of long, thread-like masses called spore horns, containing many millions of spores which ooze out from small openings in the diseased tissues. The second type of spore, the ascospore, is forcibly ejected into the air from small orange or brown cushions at the surface of the canker. New infections may arise from a number of causes. Spores which are washed down the trunk of the tree may lodge in a wound and, if conditions are favorable, germinate and give rise to a new canker. Spores are also transported from one tree to another by such agencies as the wind, birds, and insects. The shipment of diseased nursery stock, or of unpeeled, diseased logs, or of diseased bark to tanneries, is also responsible for the origin of new centers of infection, which are frequently at considerable distances from the main area of the disease.

The display of chestnut blight material, obtained from Pennsylvania, shows some of the more characteristic aspects of the disease, particularly various stages in its development. Following is a list of the various specimens on exhibit:

Young, orange-colored cankers, a month or six weeks old, on chestnut twigs.

A series of specimens showing the gradual increase in size and the successive stages in the development of the cankers from the young lesions to the last stages on the trunk of a forest tree.

Specimen from which the diseased bark has been torn off by the wind, leaving the wood uninjured but exposed.

Section of a 5-inch tree with a large canker. Trees of all sizes, whether in the forest or the orchard, are killed in the course of a few seasons.

Cankers showing characteristic hypertrophy, or swelling of the tissues; also others showing characteristic atrophy, or shrinking of the tissues.

Cankers showing both kinds of reproductive bodies: the thread-like spore horns and the brown cushions from which the ascospores are forcibly ejected.

A cluster of sprouts, or "suckers," badly diseased at their base.

Normal leaves and burs, and leaves and burs of the same age, but greatly undersized, due to cankers on the limb or trunk below. Specimens are shown of both the native chestnut and the Paragon variety, the latter furnishing a good share of the nuts sold on the market.

A miscellaneous collection of specimens showing a variety of conditions and points of interest.

FLOWERING PLANTS FOR ST. LOUIS

The two preceding numbers of the BULLETIN have dwelt in considerable detail upon the trees and shrubs that are best adapted as flowering material for St. Louis. These two groups of plants serve primarily as a setting for the third group of plants, annuals and perennials. The latter plants should be grown along the edges of the shrubbery border, but care must be observed not to plant them in long, even rows, giving the appearance of an extended band or ribbon. This effect can be easily avoided by a selection of annuals or perennials differing in color, height, and time of blooming.

PERENNIALS

Perennials are best planted early in the fall, or it might be said, most conveniently planted at that time, as they then have a chance to become established, and may even make some growth, before cold weather begins. A slight mulching of leaves or well-rotted manure will carry them through very severe winters. In other parts of the country it is the rule to wait until frost is in the ground before mulching, but as this often does not occur in St. Louis before December or even January, it is recommended that the mulch be applied late in November. It should then be spread lightly —not over two inches at the most, except for the perennial bulbs—a heavy layer tending to smother the plants. It is better to leave the crown of the plant nearly exposed and to apply the manure primarily for the purpose of covering the root growth. In the spring the mulch may either be removed or spaded into the soil.

The failure to transplant perennials at the proper time is probably the reason they are usually lacking in bloom the first season after transplanting. Because of the attendant difficulties, very few growers attempt to move their perennials at the most suitable period, but transplant either in spring or fall and take whatever bloom may come the first year, knowing that the second year the plant will again be normal. When to move a well-established perennial is a question to which the habit of the plant suggests an answer.

All perennials immediately after flowering enter into a semi-dormant or resting period, in the case of the iris, considerable root growth being made at that time. If transplanted at the beginning of this period, in two weeks or a month they will have completely established their root systems in the new soil. Some of the early flowering plants, if cut back to the ground immediately after flowering, put out new top growth and bloom again before fall.

It should always be remembered that plants that are coming into flower are putting forth their best efforts toward perfect flowers, and eventually perfect seed, and a large amount of nourishment is required. Watering of perennials should therefore be attended to regularly until they have bloomed, but after blooming, during the period of rest, very little, if any, water is required.

The following list does not include all of the perennials that may be grown in St. Louis, but it does include a large number of those that are most easily cultivated and that are productive of the best results. From this list all early flowering bulbs, such as tulips, narcissus, hyacinths, etc., have been omitted.

Achillea.—This valuable perennial, commonly known as the milfoil or yarrow, is easily grown and thrives well in St. Louis. The different species vary both in habit and in color of flowers and by a proper selection of them, the plant may be had in bloom from May until October. *Achillea Eupatorium, E. filipendulina,* and *A. tomentosi* are yellow-flowered varieties that are respectively 4, 3, and 1 foot high, and bloom from June to August. *A. Millefolium,* "Cerise Queen," and *A. Millefolium roseum* are rose-colored varieties, 2 to 3 feet high, which bloom during midsummer. The prettiest of the milfoils and the most desirable for garden use are the varieties of *A. Ptarmica,* namely, "The Pearl" and "Boule de Neige," both of which produce masses of small white flowers very unlike the other milfoils, the former being a single variety and the latter double. They are also desirable because of their low habit, being from 1 to 2 feet high.

Alyssum.—*Alyssum saxatile compactum* and *A. saxatile flore pleno* are low-growing, yellow-flowered perennials that bloom in early spring—a time when yellow is rather uncommon in St. Louis gardens. They have grayish foliage and make an attractive border plant during the summer.

Anchusa italica.—The common name for this species is the alkanet. It is a plant of rapid growth requiring considerable room for full development. As is true of

nearly all perennials, it grows easily from seed and if sown in August and wintered in a cold-frame will produce flowers the following season. The flowers are of a gentian blue and are borne at a height of about 2 to 3 feet. At this point, the main stem begins to branch and these branches in turn produce flowers, so that the plant under favorable conditions blooms the better part of middle summer. In late summer the alkanets become shabby and the flower spikes will need to be cut off. It is then desirable to have some plant that can be used as a filler; or, what is probably better, the alkanets may be cut back immediately after flowering, thus producing a second crop in the fall. In height the plant reaches 4 to 5 feet.

Anthericum.—The Anthericum is a white-flowered plant popularly known as St. Bruno's lily. The varieties "Liliago" and "Liliastrum" are well adapted for cutting. The blooming period is from May to June or July, and, like all perennials, they require an abundance of water during that time. In height, the plant ranges from 4 to 5 feet.

Aquilegia or columbine.—Columbines may be had in a great variety of colors and with an almost unlimited variation in the spurs that are characteristic of the flowers. These plants seldom do well in this locality when exposed to the full sun, and it is a general practice to plant them where they obtain full sunlight for only part of the day. They require a few years to become well established but are well worth the time and care. Their blooming period is rather early—about May and June. *Aquilegia chrysantha,* a yellow-flowered variety, is the one most grown in St. Louis, but attention should be called to the vastly superior hybrids of *Aquilegia caerulea* which are mainly blue with white and red markings. Plants of this genus vary in height from 2 to 4 feet.

Aster.—The perennial asters, or Michaelmas daisies, must not be confused with the annual asters, which, by the way, belong to an entirely different genus. The former are particularly desirable for their masses of flowers which bloom as late in the fall as the goldenrod. They vary in height from the low-growing *Aster alpinus* to the very tall *Aster tataricus.* So far as is known, all the asters do well in St. Louis and should be more generally grown. Their one objection is the fact that they are worthless in the garden the greater part of the year, on account of their short and late blooming period. This is more than offset, however, by the mass of charming colors that they add when nearly all else is gone. Their variety gives plenty of room for choice and

reference may be had to nursery catalogues for variety descriptions.

Asclepias tuberosa.—Pleurisy-root or butterfly-weed is the common name for this plant which is often found growing wild in the vicinity of St. Louis. Its adaptability to local conditions need hardly therefore be questioned. Blooming from August to September and producing flat umbels of orange-colored flowers, it is a most satisfactory plant. It is best used at the edge of the perennial groups as it flowers when about 18 inches high.

Baptisia.—The Baptisia, or false indigo, may be had in two colors, blue or yellow. The flowers are shaped like the sweet-pea but are borne on erect racemes. They bloom in May or June in this locality, and although the flowering period is of short duration, they make a brilliant spot in the border when they do bloom. The equally attractive black pods which follow the flowers, and the grayish wax-like foliage make the plants desirable until frost. The principal varieties are *B. australis,* blue, and *B. tinctoria,* yellow. When in bloom, the height of the plant is about 3 feet.

Boltonia.—This is known also as the false chamomile or false starwort. It is an aster-like plant that would combine well with *Aster tataricus* as a background for the perennial border. Three species are worthy of mention, namely, *B. latisquama,* lavender, *B. asteroides,* white, and *B. latisquama nana,* pink. The two former are 6 feet high, while the latter is only 2 feet in height.

Campanula.—Included in this genus are the plants commonly known as Canterbury bells, bell-flowers, cup-and-saucer plants, etc. The principal species grown locally are *C. Medium* (Canterbury bell), and its variety *calycanthema* (cup-and-saucer). A less common variety is *C. pyramidilis,* which is a much taller plant and may be had in blue or white. Like the aquilegias, campanulas seem to thrive better in partial shade. This is especially true in the case of *C. Medium,* wilting and decay taking place when the plant is left in the hot sun after a rain. When grown in shady locations or under conditions of even temperature, however, a diseased plant is seldom seen. After transplanting, a whole season's growth is required before flowering can take place, and when raised from seed two or more years is necessary.

Cassia Medsgeri.—This plant, commonly known as the senna, is found growing wild in Missouri. It attains a height of 5 to 6 feet and produces masses of yellow, pea-like flowers in August, which are followed by black seed pods in the fall.

The plant is desirable for the background of the perennial border.

Hardy Chrysanthemums.—In recent years the variety of chrysanthemums that are available for outdoor planting have become very numerous, both pompon and single sorts being available. As garden subjects, they are desirable because of their late blooming period and their ability to withstand early frosts. The varieties growing about St. Louis are mostly old types and should be replaced with newer and more attractive sorts. *C. maximum* and some of its varieties, such as the "Shasta Daisy," for instance, bloom from July until late fall. No garden should be without some of these plants.

Coreopsis.—*C. lanceolata grandiflora,* commonly known as the tickseed, is a valuable plant for the perennial border. The masses of yellow flowers are produced in June, and if the plant is cut back after flowering, another crop may bloom later in the season. A few seeds sown in the border will soon show how easy to grow and how hardy the coreopsis is. The best effects are obtained, however, by planting it in small groups about the garden. The flowers make beautiful cut specimens.

Delphinium or Larkspur.—Most gardeners about St. Louis seem to find larkspurs rather hard plants to handle, but success is largely a matter of getting them established. Like the aquilegias, however, they are among the plants that do not take kindly to our warm summers, and their culture, even though highly desirable, will not be successful without very great care. *D. formosum* and its varieties seem to do better than *D. chinense.*

Dinathus.—These plants, ordinarily known as Sweet-Williams or hardy pinks, are an important addition to the list of perennials. The flowers are produced in June and may be obtained in a variety of colors. Although the flowering period is short, the plants retain their dark green foliage and are always attractive as an edging for the perennial border.

Digitalis.—Digitalis, commonly called foxglove, is a desirable garden subject on account of the vertical lines of the flower. The plant itself is low-growing, and care must be taken not to crowd it with taller material. This is another perennial that is better grown in partial shade, since it is easily affected when exposed to the hot sun immediately after a rain. It blooms during July and August and attains a height of 3 feet. The flowers are yellow, white, pink, and purple, the gloxinia-flowered varieties being the most attractive.

Echinacea.—Plants of this genus, commonly called the purple cone-flowers, are desirable for a dry locality. Some of the species are native about St. Louis. They bloom for several weeks from July on, and the purplish flowers produced at a height of 4 to 5 feet, are very attractive. The high disc of the flowers and the angle at which the rays are pointed downward are charming features of the Echinacea. They are also excellent flowers for cutting, lasting for several days.

Funkia or day-lily.—These are Japanese perennials producing attractive masses of broad shiny foliage, and during July and August, lily-like flowers that may be obtained in white, lavender, and blue. They thrive best in shady locations along water courses or pools. *F. albo-marginato* and *F. aurea variegata* have variegated leaves. *F. coerulea* has light blue and *F. Sieboldiana* has pale blue flowers. Besides these varieties, any nursery catalogue will give a list of many others that are well worth growing.

Helenium.—Too much emphasis cannot be laid upon the desirability of growing heleniums or sneezeweeds. They produce an abundance of flowers about an inch in diameter. *H. autumnale superbum* has golden yellow flowers produced at a height of 5 to 6 feet. There is also a red-flowered variety of the same habit, known as *H. autumnale superbum rubrum,* and an orange-flowered form known as *H. Hoopesii.* Because of their height, heleniums had best be planted at the back of perennial backgrounds.

Helianthus.—To this genus belong the perennial sunflowers. Of course, the flowers are yellow but the breeder's art has produced a considerable variation in size, profusion, and form. They are easy to grow and the flowers are good for cutting. Their variety is legion but it would seem best to plant them only in limited quantities as there are so many plants more desirable.

Hemerocallis or yellow day-lily.—Besides being one of the most beautiful and popular of the day-lilies, this plant flowers freely from small plants the first year. The flowers are short-lived, but because of the rapid succession of bloom, this is no objection. Hemerocallis will grow well anywhere but likes best the areas near pools and streams. It is perfectly hardy and requires little protection. Of the varieties, *H. aurantiaca* is yellow-flowered, blooms in June, and grows 2 to 3 feet high; *H. flava* has the same general habit and *H.* "Orange Man" has orange flowers. There are also many other varieties which are well worth growing.

Hollyhocks.—Attention is merely called to these plants as a reminder. Their place in the garden is one of importance

and the variety of coloring in both singles and doubles is almost innumerable.

Iris.—The variety and use of the iris as decorative perennials are such that they need no particular description. The May, 1914, BULLETIN, however, contains a complete discussion of their treatment and culture.

Liatris.—Liatris, or blazing-star, is a native plant that has come into general use in St. Louis in recent years. The flowers are purplish blue and are produced in dense cylindrical spikes about 3 to 4 feet high. They bloom in late summer and autumn, and a rather complete succession may be obtained if the species, *L. pycnostachya, L. scariosa,* and *L. spicata* are used together. The first is perhaps the earliest, blooming in August. *L. spicata* comes next, and is followed by *L. scariosa.* They are all valuable in producing the vertical effect that tends to relieve the monotony of any border plantation.

Linum or flax.—This is a perennial that is easy to grow and adds a pleasing touch of color to the garden, especially when grown in masses. *L. flavum* is a good variety that grows from 1 to 2 feet high and produces golden yellow flowers in July and August. *L. perenne* (blue) and *L. perenne album* (white) bloom at the same time as *L. flavum,* but are more dwarf, being 1 foot to 18 inches high. The flax grows easily in the full sun and has a long period of bloom.

Lilium.—The impression seems to prevail in St. Louis that the liliums, or lilies, as they are popularly called, are hard to grow and possess little merit as perennials. For this reason, they are usually treated as tulips and other bulbs. The first season after planting the results are usually satisfactory, and when the ground, as well as the plants themselves, are protected from the intense drying effect of the sun, success may be looked for in succeeding years. Planting bulbs in the low shrubbery or between other perennials furnishes the necessary protection to the roots and flowering stems. Among the lilies most recommended for local conditions are *L. auratum, L. speciosum album,* and *L. speciosum rubrum.*

Lobelia.—Where moist conditions prevail, no plant is more attractive than the lobelias or cardinal flowers. They are best grown along streams or pools, although when plenty of water is provided they do well in any garden location. *L. cardinalis* is a red-flowered and *L. syphilitica* is a blue-flowered species, both offering a nearly continuous bloom during the summer. The spikes vary in height from 2 to 4 feet.

Lychnis.—This is a genus of many species but no garden possessing a damp spot should be lacking in *L. chalcedonica.* It has dense heads of red or scarlet flowers blooming from June on. A lower-growing species, *L. Haageana,* is about 1 foot in height and is grown for its brilliant scarlet flowers.

Matricaria.—The Matricaria or feverfew is closely related to the chrysanthemum. *M. capensis fl. pl.* is an especially desirable variety because of its masses of double white flowers, and if it is cut back after the first flowering period, can be made to bloom continuously.

Monarda.—This plant is called the horse-mint or bergamot owing to its aromatic foliage. It is a desirable plant to grow, but seems to prefer moist situations. The following varieties are recommended: *M. didyma rosea* (rose) and *M. didyma splendens* (scarlet), both of which are 18 inches high and bloom from July to August; *M. fistulosa alba* (white), 2 feet in height; and *M. Russeliana* (pale blue), 2 to 3 feet in height.

Myosotis.—This is a beautiful low-growing perennial commonly called the forget-me-not. It grows easily from seed but only does well where both soil and air are moist, and dries up under a hot sun.

Oenothera or evening primrose.—This is a genus of plants which is most ornamental and desirable for the garden. Because of the closing of the flowers during the day they are best seen in the late afternoon or early morning. *O. missouriensis,* often found growing wild about St. Louis, is a low-growing plant 6 inches high with very large yellow flowers spotted with red. *O. Youngii,* 2 feet high, is another species very commonly grown for its large flowers. The plants seem to thrive exceptionally well under St. Louis conditions and should be used more. There are a number of commercial varieties.

Paeonia.—Although St. Louis gardens are lacking in the charm that would come from the use of a larger variety of these well-known plants, it would be impossible in this short paper to call attention to the merits of the many species that may be grown in this locality. The main objection to paeonies, as garden plants, comes from their unsightly appearance after the blooming period, which makes it necessary to plant annuals or perennials between them as fillers for the summer and fall.

Papaver or poppy.—Attention is particularly called to the Oriental poppies which may be obtained in all shades of red and orange. The flowers are large and remind one when in bloom of giant tulips. Like the paeonies, they require

a filler plant during the summer. However, this filler should not be allowed to monopolize the ground when the poppies start to make their growth in the fall, for at this time they grow fast and winter finds them with a luxuriant crown of foliage that lives until frost.

Physostegia.—False dragon-head is the common name for this tall native perennial. It grows 3 to 4 feet in height and thrives best in sunny locations. The varieties, *P. virginiana* (pink) and *P. virginiana alba* (white), produce showy spikes of flowers from July on, which are most effective when used in large masses against a green background.

Pentstemon or beard-tongue.—The Pentstemon and Physostegia may be grown in the same localities and have many other points of resemblance as to habit and appearance. By choosing certain sorts, a variety of colors may be obtained consisting of purple, white, blue, and violet. They bloom in July and August and average 2 to 3 feet in height. Some of the better varieties are *P. barbatus Torreyi* (scarlet red), *P. Digitalis* (white), *P. grandiflorus* (lilac blue), and *P. pubescens* (dull purple or violet).

Phlox.—The perennial phlox is a large class of plants, which for showiness and attractiveness during the midsummer months cannot be surpassed. They vary in height, color, and time of bloom, and are to the midsummer season what the iris and paeonies are to the spring, and the goldenrod and asters are to the fall. A number of the phlox species bloom in early spring, such as *P. subulata,* and its varieties, and *P. suffruticosa* and its varieties. The midsummer varieties are usually catalogued under the names, *P. decussata* or *P. paniculata, P. Drummondii* of the catalogues being an annual.

Rudbeckia or cone-flower.—The rudbeckias, because of their late flowering period, are considered among the most attractive of the perennials. They are perfectly hardy and free-flowering in all conditions of weather, whether dry or wet. *R. fulgida,* an orange-colored species blooming in August and September, is from 1 to 3 feet high. *R.* "Golden Glow," the most common Rudbeckia, reaches a height of 5 to 6 feet, and blooms when the height is reached. *R. purpurea,* the giant purple cone-flower, grows from 2 to 3 feet in height and is conspicuous because of its large reddish purple flowers with drooping rays and large brown cone-shaped disc. The flowers of all the species are well adapted for cutting.

Salvia or sage.—Most people are familiar with the annual scarlet sage, but few know of the beauty of the blue-flowered

salvias. *S. azurea grandiflora,* or the Rocky Mountain sage, grows to a height of 6 feet and blooms from August on. *S. argentea,* growing only 2 to 3 feet high, produces pinkish white flowers in June, and *S. pratensis,* showy spikes of deep blue flowers from June to September.

Solidago.—In conjunction with masses of the hardy asters, the Solidago or goldenrod produces most of the fall color in the garden. *S. canadensis* is one of the commonest and still one of the best species. No garden is complete without it, and with good care and in good soil, it far surpasses in beauty the wild species.

Tritoma.—These plants, known also as the torch-lilies, or red-hot poker plants, require protection during the winter, but their spikes of bright flowers coming in late or middle summer are well worth the little effort taken to grow them. The colors vary from yellow to orange and red, the red species being the most striking. The species most commonly grown are *T.* "Express" (orange), *T. Pfitzerii* (orange scarlet), *T. rufa* (canary-yellow), and *T. Tuckii* (deep red).

Veronica or speedwell.—This is a large and much cultivated group of blue-flowered perennials, consisting of tall and fairly dwarf varieties. Their color and their long blooming period make them very desirable garden subjects. *V. longifolia subsessilis* is the handsomest blue-flowered perennial known. It grows to a height of 2 feet and the spikes are completely covered with brilliant blue flowers which make beautiful cut specimens. It blooms from August until frost and is readily propagated from cuttings. *V. spicata,* while not to be compared with the former, is a pleasing species prized for its pale blue flower spikes. *V. repens* is a creeping or trailing variety with pale blue flowers and is a good plant for low places at edges of walks or perennial borders.

Yucca or Spanish needle.—No collection of perennials is complete without a few of these much-prized plants. They make continuous points in the border and their leaves are evergreen. When the tall spikes of waxy white flowers appear, there are few plants that can surpass them. *Y. filamentosa,* growing 4 to 5 feet high and blooming in June, is the species most commonly grown.

ORNAMENTAL GRASSES

For producing light tropical effects at certain points in the shrubbery, and especially along streams or at the edges of pools, nothing is quite as attractive as the grasses. They require but little care and seem to improve with age. The best varieties are the following:

Arundo Donax.—This species, known as the giant reed, grows 10 to 15 feet high. There is also a variegated variety.

Erinathus Ravennae.—This is a purplish-leaved grass growing 4 to 7 feet high. The plumes are fine for winter decorative use.

Eulalia.—This genus, sometimes catalogued as Miscanthus, is one of the best and most common grasses grown. Of the desirable species should be mentioned *E. gracillima univittata,* with narrow leaves and *E. japonica* and it varities, *variegata* and *zebrina,* the first-mentioned having broad leaves and the latter two, variegated leaves.

Gynerium argenteum elegans.—Pampas grass is the popular name for this species. Its long, silky plumes and narrow leaves are well known and need no description.

Pennisetum Ruppellii.—This is commonly called the purple fountain-grass. It is one of the most desirable grasses and is considered hardy, but in this locality it is usually best to treat it as the cannas; that is, it should be lifted and stored for the winter.

Phalaris arundinacea variegata.—The common name for this species is the variegated ribbon grass. It grows about 18 inches high and is a fine plant for edging beds of either flowers or grasses. If cut back so that it is forced to produce new growth it will always stay variegated, but if this is not done it soon becomes green.

This concludes the list of the hardy plants that may best be grown in and about St. Louis. While it is impossible to make such a list complete, it is believed that a garden which includes the plants enumerated will successfully withstand the conditions of the St. Louis climate, and a more satisfactory result will be obtained than from an indiscriminate selection of material not adapted to this region.

SUNDAY OPENING DURING THE WINTER MONTHS

By vote of the Trustees, the months during which the Garden shall be open on Sundays have been extended to include every month of the year. This action was due to the evident appreciation of the public of the opportunity to visit the Garden on Sunday afternoons from April to December, and the belief that the exceptionally fine flower shows maintained during the winter would furnish an attraction which warranted an extension of this privilege.

Beginning with the first Sunday in December and continuing until the first Sunday in April, the Garden will be open on Sundays from one o'clock till sunset. From April

to December the Garden will be open each Sunday afternoon from two o'clock until sunset. As in the past, the Garden will be open on week days from eight o'clock until one-half hour after sunset. With the exception of the four holidays, New Year's, Fourth of July, Labor Day, and Christmas, visitors may now be admitted to the Garden every day in the year between the hours specified.

FLORAL DISPLAY FOR DECEMBER

The new floral display house which was opened to the public with the Chrysanthemum Show on the last Sunday in October has been a blaze of color during the month of November. It is not generally known, however, that this same house is to be devoted to floral displays during the entire winter, and that the shows will be quite as attractive, and in some instances, more so, than that of the chrysanthemums. Furthermore, a large portion of the flowers shown are not to be seen elsewhere in St. Louis, and both in the variety of foliage and flowers and in the arrangement of colors, many new and pleasing combinations will be found. Most florists grow only those plants for which there is a demand, but it is the aim of the Garden to create an interest in, and a demand for, plants with which the average person is not familiar.

The December display will be decidedly a Christmas show, the prevailing colors being red, green, pink, and white. Thousands of poet's narcissus and the Chinese sacred lily (also a narcissus), will be used as a setting to display the potted plants of begonia, "Gloire de Lorraine," and the pans of dwarf poinsettia. Giant plants of poinsettia will vary the outline here and there, while the usual-sized plants will be used as the main background; over a thousand poinsettias being shown in all. Banks of variegated stevia and white-flowered eupatoriums will be used to set off the red flowers. Throughout the entire house and binding together the groupings of plants will be some 2,000 plants of *Begonia Erfordii,* in shades of red, pink, and white. A small group consisting of some of the best varieties of Erica or heather will also be shown, some of the plants in this group being 5 feet high and 3 to 4 feet broad. The entire display will be bordered with hundreds of plants of *Solanum pseudocapsicum* or the Jerusalem cherry.

In the orchid house during the month, and especially near Christmas, there will be probably the largest number of blooming orchids that has ever been shown at the Garden. The display will consist in the main of several

hundred plants of *Dendrobium Phalaenopsis,* or the elephant moth orchid, which, at their height, will produce thousands of flowers, shading from white to pink and dark pink. Specimens of the beautiful blue moth orchid or *Vanda coerulea* will be intermixed with the others. This is one of the very few blue-flowering orchids coming to us from the East Indies, and its shadings are so varied that it seems impossible to get two alike. A miscellaneous collection of the lady slipper orchid or Cypripedium will also be shown, as well as many flowers of the more common lavender-flowered cattley orchid or *Cattleya Trianaei.*

NOTES

About 150 ladies in the National Coffee Roasters' Association party visited the Garden, November 10.

Dr. James A. Blaisdell, President of Pomona College, Claremont, California, was a Garden visitor, November 8.

Mr. Fred A. Grossart, who graduated from the Garden Course this September, is now Head Gardener at Valhalla Cemetery, St. Louis County.

Mr. W. W. Ohlweiler, General Manager of the Garden, attended the Chicago Flower Show, November 9, and the Cleveland Flower Show, November 10 and 11, in the interest of the Garden.

Recent visitors to the Garden include Dr. A. C. True, Director, States Relations Service, U. S. Department of Agriculture, on November 18, and Professor P. H. Rolfs, Director, Florida Agricultural Experiment Station, Gainesville, Florida, on November 19.

The St. Louis Florist Club held their regular meeting in the graduate lecture room of the Missouri Botanical Garden on Thursday, November 18. The most important business transacted was the decision to hold a flower show worthy of St. Louis in the spring of 1917.

The Graduate Club of Washington University met at the Garden on Sunday, November 14. After the usual business session, a tour was made of the buildings and grounds, particular interest being manifested in the Chrysanthemum Show and in the collection of orchids.

The annual Gardeners' Banquet, provided for in Mr. Shaw's will, was held November 19 at the Liederkranz Club. Mr. John K. M. L. Farquhar of Boston, President of the Massachusetts Horticultural Society, and Past President of the Society American Florists and Ornamental Horticulturists was the speaker of the evening.

A meeting of the Missouri Botanical Garden Alumni Association was held in the graduate lecture room of the Missouri Botanical Garden on November 19. It being a called meeting, no business was transacted, but an interesting program was presented. Dr. George T. Moore, Director of the Garden, spoke informally, and Mr. A. R. Gross responded on behalf of the alumni with a review of the year's work of the Association. Mr. John Noyes, Landscape Designer to the Garden, read a paper on "The Pursuit of Beauty," and in the afternoon Mr. L. P. Jensen spoke on "The Use of Native Material for Ornamental Planting." After a discussion and reports of committees, the meeting was adjourned. In addition to the St. Louis members, the following from out of town attended: Mr. Charles W. Deusner of Batavia, Illinois; Mr. A. R. Gross and Mr. Rudolph J. Mohr of Chicago; Mr. Walter H. Nehrling of Charleston, Illinois; Mr. J. Hollister Tull of Mena, Arkansas. The president, Mr. Arno H. Nehrling, of Massachusetts Agricultural College, was unable to be present but sent an interesting letter which was read.

STATISTICAL INFORMATION FOR OCTOBER, 1915

GARDEN ATTENDANCE:

Total number of visitors.....27,656

PLANT ACCESSIONS:

Total number of plants and seeds received in exchange.....	154
Total number of plants distributed in exchange.....	47
Plants donated	28
Total number of plants distributed.....	286

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought.....	12
Total number of books and pamphlets donated.....	360

HERBARIUM ACCESSIONS:

By Purchase —

F. V. Coville—Plants of Mexico, collected by Dr. Edward Palmer in 1910.....	512
Stuart L. Thompson—Plants of Manitoba.....	145

By Gift —

W. H. Ballou—*Peniophora filamentosa* from New York....	1
Robert Bebb—*Juglans sp.* from Oklahoma.....	1
W. W. Bonns—Plants of California.....	5
Carl F. Deeg—*Ungnadia speciosa* Endl. from Missouri.....	1
J. A. Drushel—Plants of Missouri and Colorado.....	17
O. A. Farwell—Plants of Michigan.....	33
H. R. Fulton—Black rot of apple roots.....	3
J. M. Greenman—Plants of Staten Island, N. Y.....	7
John H. Kellogg—*Hicoria villosa* Sargent, from Missouri..	4
Roy Latham — *Stereum albobadium* on stem of Brussels sprout	1
O. S. Ledman—Seeds of *Nectandra Puchury-minor* Nees & Mart.	1
W. H. Long—Fungi of Arizona.....	2
L. O. Overholts—Fungi of Pennsylvania.....	4
John H. Schlachter—*Silene sp.* cultivated at Gillespie, Ill...	1
M. P. Somes—*Koelreuteria paniculata* Laxm. cultivated at Missouri State Fruit Experiment Station.....	1
Edward Teas—*Malpighia glabra* L. from the Rio Grande region, Texas	2
H. von Schrenk—Fungi rotting railway ties from Indiana, Pennsylvania, and Texas.....	12
J. R. Wier—Fungi from British Columbia, Montana, Idaho, and Washington	155
S. M. Zeller—Fungi of Missouri.....	14
TOTAL.....	922

The Garden is open to the public every day in the year, except New Year's, Fourth of July, Labor Day, and Christmas—week days from 8:00 A. M. until one-half hour after sunset; Sundays, from December to April, 1:00 P. M. until sunset, from April to December, 2:00 P. M. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

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C. R. FOLLEN,
Construction.

M. SCHILLER,
New Conservatories.

P. FOERSTER,
Farm and Stables.

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1

2

3

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EXAMPLES OF CHLOROSIS

1. EUONYMUS JAPONICUS VAR. AUREO-VARIEGATUS. 2. GOLDEN CLUB MOSS (SELAGINELLA KRAUSSIANA). 3. A VARIEGATED PRIVET (LIGUSTRUM OVALIFOLIUM VAR. AUREO-MARGINATUM). 4. BOUGAINVILLAEA GLABRA VAR. SANDERIANA VARIEGATA.

Missouri Botanical Garden Bulletin

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VARIEGATED LEAVES

The majority of mature plants are dependent entirely upon their leaves for the formation of organic matter from inorganic—a function which, with the exception of some of the bacteria, is confined exclusively to the substance called chlorophyll, which gives the green color to the leaf. The tremendous importance of this ability to convert the simple inorganic substances, carbonic acid and water, into a complicated organic substance readily transformed into a carbohydrate, like starch, makes chlorophyll one of the most fundamental products of nature. Consequently, any condition which interferes with the normal formation of "leaf green" is of serious import to the plant, and the occurrence of white or variegated leaves is an interesting phenomenon, worthy of study. It is a well-known fact that, with very few exceptions, sunlight is necessary for the production of chlorophyll, and plants grown in the dark are always yellowish, due to the more or less complete absence of this green substance. It is not this type of bleaching, however, which is to be discussed, but rather the mottling, striping, white edging, etc., so commonly seen in the leaves of cultivated plants growing under normal conditions.

Most of these variegated varieties have originated from cuttings made from branches showing this peculiarity, or from plants which have suddenly, for no particular reason, so far as the ordinary observer could detect, produced leaves with white markings. A visitor to the Garden might very properly ask what has caused a plant, normally green, to develop conspicuous yellow or white areas, although growing in direct sunlight. Why is it that some plants have branches with green foliage, while other branches bear variegated leaves? Why is a leaf spotted with yellowish or white patches instead of being of one color? While all of these questions cannot be answered with absolute certainty, careful study has developed some interesting facts concerning this variegation, or chlorosis, as it is technically termed.

For instance, we know that iron and magnesium salts are necessary to the formation of chlorophyll, and that without these chemicals plants will become colorless and may eventually die. Again, some types of variegation take place only in the sunlight, and the mere transfer of the plant to a shady place enables the new leaves to be of the normal green color. Injuries likewise produce chlorosis of different types, and instances of bleaching in cabbage, parsley, and similar garden crops which have been nipped by an early frost are common. Damage induced by insects or unfavorable conditions of the soil may also cause leaves and tender stems to lose their green color, although yellowing due to injury, lack of food, etc., is in general very different from what we ordinarily term variegation or true chlorosis.

Baur, a German botanist, has obtained some interesting results by grafting scions from certain variegated plants on stocks of normally green varieties of the same species. He demonstrated that in some cases stocks thus grafted would later produce variegated foliage, and he consequently believed that the cause of the variegation in the scion is transmitted to the stock.

There seem to be two distinct forms of chlorosis, however, the one, infectious, and the other, non-infectious, since with some plants it is impossible to produce any effect on the stock, even though it be grafted with a variegated variety, and one plant (*Euonymus japonicus*) was found to possess both the infectious and non-infectious forms. It is likewise true that some varieties are immune to the infectious chlorosis which is readily transferred to other closely related forms. Among the plants which show what is supposed to be non-infectious variegation are *Bougainvillaea glabra Sanderiana, Fittonia argyroneura,* the silver-banded geranium (*Pelargonium hortorum* var. *albo-marginatum*), varieties of elephant's ears (Caladium), which show some of the most remarkable instances of absence of chlorophyll, as well as the numerous striped and banded grasses.

An interesting example of what is apparently an infectious chlorosis may be seen in the whitened tips of the club moss (*Selaginella Kraussiana*) growing in the fern house at the Garden. Such variegated forms are always propagated by cuttings, but are never inherited through the seeds. This is not true, however, of the variegation due to non-infectious chlorosis, which is perpetuated through the seed. If the juice of a plant, like tobacco, having an infectious chlorosis comes in contact with a wound on any part of a normal plant of the same kind, the latter may show symptoms of the dis-

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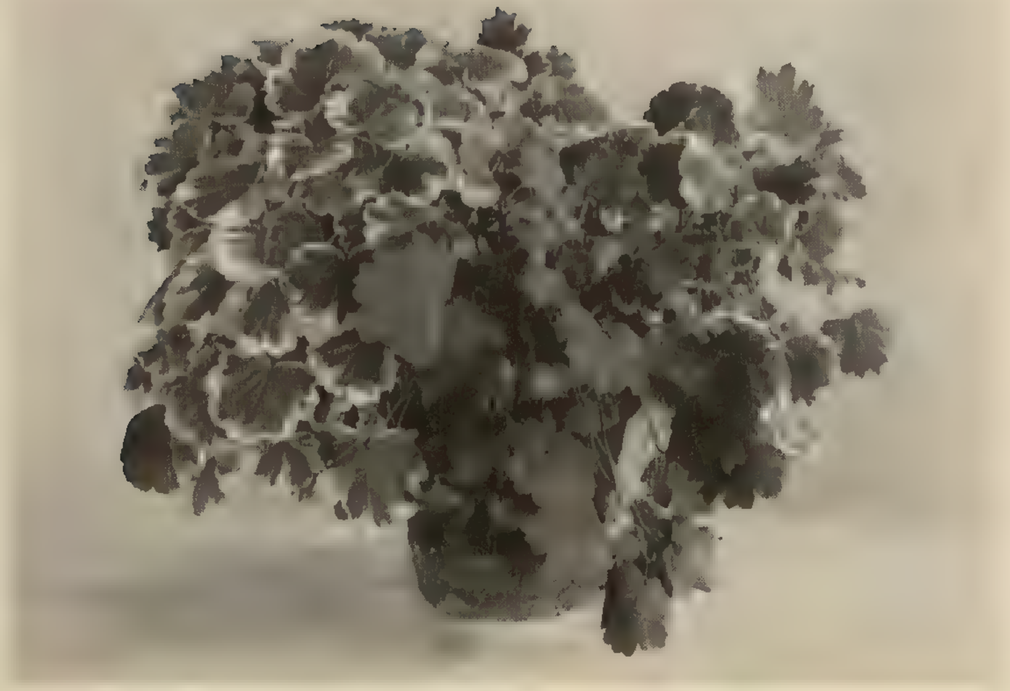

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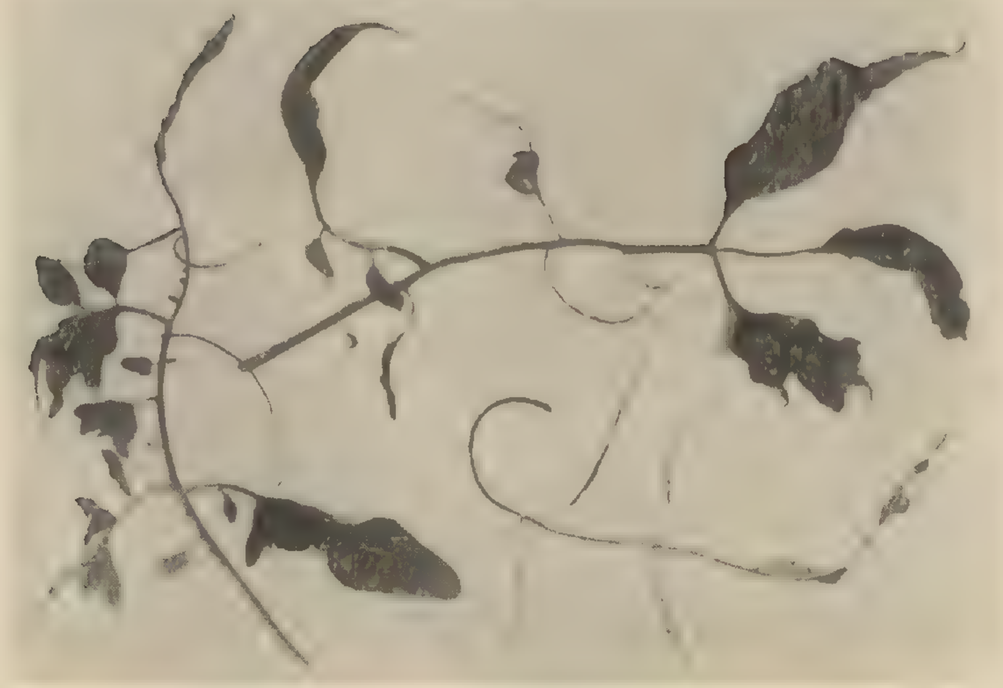

4

1. MOSAIC DISEASE OF TOBACCO. 2. FITTONIA ARGYRONEURA SHOWING WHITE VEINATION. 3. PELARGONIUM HORTORUM VAR. ALBO-MARGINATUM, SHOWING CHLOROSIS. 4. MOSAIC DISEASE OF TOMATO.

ease within a week or two. From the point of infection the disorder spreads rapidly to various parts, since the juice of the diseased tissue is extremely virulent. One part of this substance in 10,000 parts of water has been shown to be capable of producing a serious attack of the disease, and dried plants are known to retain their ability for reproducing the disease in other plants for at least two years. It will readily be seen how easy it is to communicate such an infection from plant to plant, and the loss due to "chlorosis" diseases of such crops as tobacco, tomatoes, peaches, beets, etc., is very serious.

Perhaps the so-called "mosaic disease" of the tobacco, due to an infectious chlorosis, has been most carefully studied. This disorder may appear in the seed beds while the plants are still small, but more often it occurs in the mature plant in the field. The mosaic usually develops first in the very young leaves and when once started is practically incurable. The first apparent symptom is a mottling of the leaf, due to the partial disappearance of the chlorophyll, in irregular blotches. At these points the tissue does not develop normally, and the unequal growth causes a crinkling of the leaf as shown in the accompanying plate (Plate 11). Still later there may be produced long narrow leaves which ultimately may develop into nothing more than thin string-like strands, this latter condition occurring most frequently in the tomato (Plate 11). All plants thus affected are, of course, stunted because of the malnutrition induced by the absence of chlorophyll.

Various theories have been advanced as to the cause of the mosaic disease of tobacco and tomato. While some have held that the elimination of the chlorophyll is due to a microorganism so small that it cannot be detected with the microscope, others believe that the disease is due to a local disturbance of the ferments of the cell or the production of toxins, and that these substances transferred from an affected plant, are capable of creating the diseased condition in the young tissues of the other plants.

HOLLY AND MISTLETOE

Holly and mistletoe are inseparably associated with the Christmas season, not only on account of their beauty and persistence during the winter months, but because from earliest times these two plants have, by tradition, been linked with the life of Christ. The most plausible origin for the

common name of holly is that it is a corruption of holy, and the German name of "Christ thorn" perpetuates the legend that leaves of this tree were used to form the "crown of thorns." The mistletoe, among many other woods, has frequently been referred to as the one from which the cross was made. Previous to the crucifixion—so runs the legend—it was a splendid forest tree, its disgraceful use causing it to assume its present humble parasitic habit.

Long before the Christian era, however, holly and mistletoe were singled out as plants of special significance. The Druids styled the mistletoe as "all heal," it being considered an antidote for all disease, and even to the present day in some localities the virtues of its wood are highly regarded. In Sweden a finger ring of mistletoe is supposed to prevent sickness, and in France amulets of this plant were much worn. Culpepper speaks of mistletoe as "good for the grief of the sinew, itch and toothache, the biting of mad dogs and venomous beasts," and Sir Thomas Brown alludes to its efficacy in cases of epilepsy.

At Roman weddings, holly wreaths were sent as tokens of congratulation, and remarkable stories concerning the powers of this tree are recorded by Pliny. In Holland's translation of Pliny's "Historie of the World," published in 1601, is found the following:

"In touching the Holy or Hulver Tree if it be planted about an house, whether it be within a city or standing in the country, it serveth for a countercharm and keepeth away all ill spells or inchantments and defends the house from lightning. Pythagorus affirmeth that the flower of this tree will cause water to stand all upon an ice, also that if a staff made thereof, if a man do fling it at any beast what-so-ever, although it chanceth to light short for default of strength in his arms who flung it, will not-with-standing, etch forward and roll from the place where it fell upon the earth and approach near to the beast aforesaid; of so admirable a nature is the Holy Tree."

THE HOLLY

To most people there are but two kinds of holly, the European (*Ilex Aquifolium*) and the American (*Ilex opaca*). The botanist, however, recognizes over one hundred and seventy-five species, which range from the North Temperate to the South Temperate zones and are found on every continent. Of this number, about fifteen occur in North America, although only five of these would be classed as trees, and but three of the latter are evergreen. Indeed, a considerable group of the hollies shed their leaves in the winter

just as other deciduous trees; but that the evergreen habit was considered a fixed characteristic of this plant is well attested by the quaint old English proverb of the confirmed prevaricator, of whom it was said: "He lees never but when the hollen is green."

Japan and China have thirty or forty species, some of which are being introduced into this country for ornamental purposes. The home of the holly, so far as number of species is concerned, may be considered to be northern Brazil, where about half the known forms occur wild. Europe has but a single species, but this deficiency is made up by there being over one hundred and fifty different varieties of *Ilex Aquifolium*—at least they are so regarded by horticulturists, but there seems to be some evidence that a part of these forms may have originated from the Canary Island species, *Ilex platyphylla,* rather than the true European holly.

That only some trees bear berries is due to the fact that in the holly the sexes are distinct; the female, or pistillate flowers, which produce the fruit, occurring on one tree, while the pollen-bearing flowers are on a separate tree. Care should be taken, therefore, in planting hollies desired for the berries, to secure only female trees. While it is believed that the first printed notice of this difference in sex was communicated by Martyn in the "British Royal Society Transactions" about the middle of the eighteenth century, it must have been known to the country people long before this, since the term "he and she hollies" is very old.

Although the usual color of the berries is red, it is not uncommon to have varieties in this country and elsewhere producing pale yellow fruits, and even white berries occur occasionally as a sport.

Economically, aside from its use for decoration, the holly is useful for furnishing a wood, which, because of its white color and even texture, is in great demand for use in carving and scroll work. Formerly, when bird-lime was in general use, the inner bark of the holly furnished the principal source of this product, and the herbalists of a century or two ago relied upon this plant for the cure of many a complaint. Perhaps one of the most novel remedies was its application in the cure of chilblains, the method being to whip the affected part with freshly gathered holly leaves until the blood flowed. *Ilex paraguensis,* widely distributed in South America, a specimen of which is growing in the economic house at the Garden, furnishes the maté or Paraguay tea and is in great demand by the natives of the coun-

try in which it is found. The beverage prepared from the leaves of this holly has a considerable stimulating effect, and the drink holds the place of tea and coffee in this country.

The American holly (*Ilex opaca*), together with some of the Japanese species, deserves to be more widely planted in St. Louis. It is the one evergreen which seems to be able to withstand the smoke of a city, and it is remarkably free from insect and other pests. Growing to a height of forty to fifty feet, with a trunk two or three feet in diameter, and branches so arranged as to produce a natural pyramidal effect, nothing could be finer than a holly tree. There is no doubt about its living from two to three hundred years, and Pliny tells us that Tiburtus built the city of Tibur near three holly trees over which he had observed the flight of birds that pointed out the spot whereon the gods had fixed for its erection, and that these trees were standing in his own time and must, therefore, be upwards of twelve hundred years old. He also says that there was a holly tree then growing near the Vatican in Rome, on which was fixed a brass plate with an inscription engraved in Tuscan letters, and that this tree was older than Rome itself, which must have been more than eight hundred years.

MISTLETOE

As in the case of the holly, so with the mistletoe, there is a distinct American and European variety. From a botanical standpoint, the difference between the two forms of mistletoe is much greater, since the European plant belongs to one genus (Viscum) and the American to another (Phoradendron). There are some eleven species of the American form, widely scattered through the south and southwest, and occasionally growing as far north as New Jersey and Ohio. Several species have been reported from Missouri, although it is rare.

While ordinarily considered a parasite, since it always grows upon some tree, the mistletoe is not strictly such. Its own leaves are capable of manufacturing food, and it is not entirely dependent upon its host, as is the case in a true parasite. The chief contribution of the host to its unwelcome associate seems to be water, with certain contained salts, and while the mistletoe does not directly kill the tree upon which it is growing, it often dwarfs and distorts the branch to which it is attached, and may furnish the opportunity for the admission of fungi which ultimately destroy the tree itself.

The distribution of mistletoe is almost entirely by birds, the seed either being swallowed whole, or because of their stickiness, adhering to the beak or feet, to become dislodged later on some favorable tree. Tradition limited this dissemination of the plant to a single bird, the "mistletoe thrush" or "misselbird," which was the messenger of the gods. Hence the occurrence of mistletoe, particularly on the oak, was held to be deeply significant. Many other trees are infested by this parasite, however, in the southwest the hackberry, elm, mesquite, and osage orange being the most common hosts.

After the seed are deposited on the branch of a tree, they usually begin to germinate as soon as moisture and temperature conditions are favorable. When the root-like portion comes in contact with the branch, it flattens out, forming a sucker-like disk. Depending upon circumstances, there may or may not be produced from this disk during the first year a process which penetrates the bark of the host as far as the wood. During the second year a single pair of leaves may be formed, and the "roots," by mechanical force and the secretion of a digestive ferment, continue to ramify the tissues of the tree upon which the parasite is established.

The mature plants are bushy in appearance and may reach the height of three or four feet. The flowers are produced in late summer or early fall so that the berries are well developed early in December. Plants of the European mistletoe have been found which were estimated to be forty years of age, but it seems probable that the American variety does not normally attain an age of more than half this number of years.

NOTES

Dr. W. T. Swingle, of the United States Department of Agriculture, was a Garden visitor on December 16.

Dr. George T. Moore, Director of the Garden, spoke before the St. Louis Medical Society, November 27, on "Plant Diseases."

Prof. F. S. Cooley and Mr. M. L. Wilson, both of Montana State College, Bozeman, Montana, were recent visitors at the Garden.

The ladies attending the convention of the Transportation and Car Accounting Officers of the Railroads of the United States visited the Garden on December 14.

On December 3, Mr. W. W. Ohlweiler, General Manager of the Garden, gave a lecture before the staff and pupils of

the St. Louis Industrial School on "Some Interesting Economic Plants."

An illustrated lecture on "Chance and Adjustment versus Purpose in the Responses and Evolution of Living Things," was given before the Washington University Association by Dr. B. M. Duggar, Physiologist to the Garden, on November 23.

The Christmas display in the new floral display house is now at its height and probably will not be replaced until the middle of January. The best show of blooming orchids ever exhibited at the Garden, referred to in detail in the last BULLETIN, will persist throughout the month of January.

The fourth number of Volume II of the Annals of the Missouri Botanical Garden has been issued with the following contents:

"Toxicity of Galactose for Certain of the Higher Plants." Lewis Knudson.

"Comparative Studies in the Polyporaceae." L. O. Overholts.

"The Thelephoraceae of North America. V." E. A. Burt.

"Enzyme Action in the Marine Algae." A. R. Davis.

STATISTICAL INFORMATION FOR NOVEMBER, 1915

GARDEN ATTENDANCE:

Total number of visitors	46,026

PLANT ACCESSIONS:

Total number of plants received in exchange	632
Total number of packets of seeds received in exchange	8
Plants donated	4

PLANT DISTRIBUTION:

Total number of plants distributed free	118
Total number of plants distributed in exchange	52

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	90
Total number of books and pamphlets donated	80

HERBARIUM ACCESSIONS:

By Purchase—	
L. O. Overholts—Plants of Ohio, Indiana, and Missouri	325
By Exchange—	
University of California—Plants of California	21
By Gift—	
W. H. Aiken—*Thevetia cuneifolia* DC. from Guatemala	1
A. H. Chivers—*Pleurotus ulmaris*, a wound parasite on elms on Dartmouth College campus	1
J. A. Drushel—Plants of Missouri, Colorado, and Texas	26
H. D. House—Fungi of New York	26
P. C. Maffitt—*Fomes applanatus* from the Adirondack Mts., New York	1
W. A. Murrill—Thelephoraceous fungi from western United States and Mexico	235
J. R. Weir—Fungi of Montana, Oregon, and British Columbia	9
Total	645

The Garden is open to the public every day in the year, except New Year's, Fourth of July, Labor Day, and Christmas—week days from 8:00 A. M. until one-half hour after sunset; Sundays, from December to April, 1:00 P. M. until sunset, from April to December, 2:00 P. M. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

☞ **The Garden will be closed all day Christmas and New Year's day.**

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